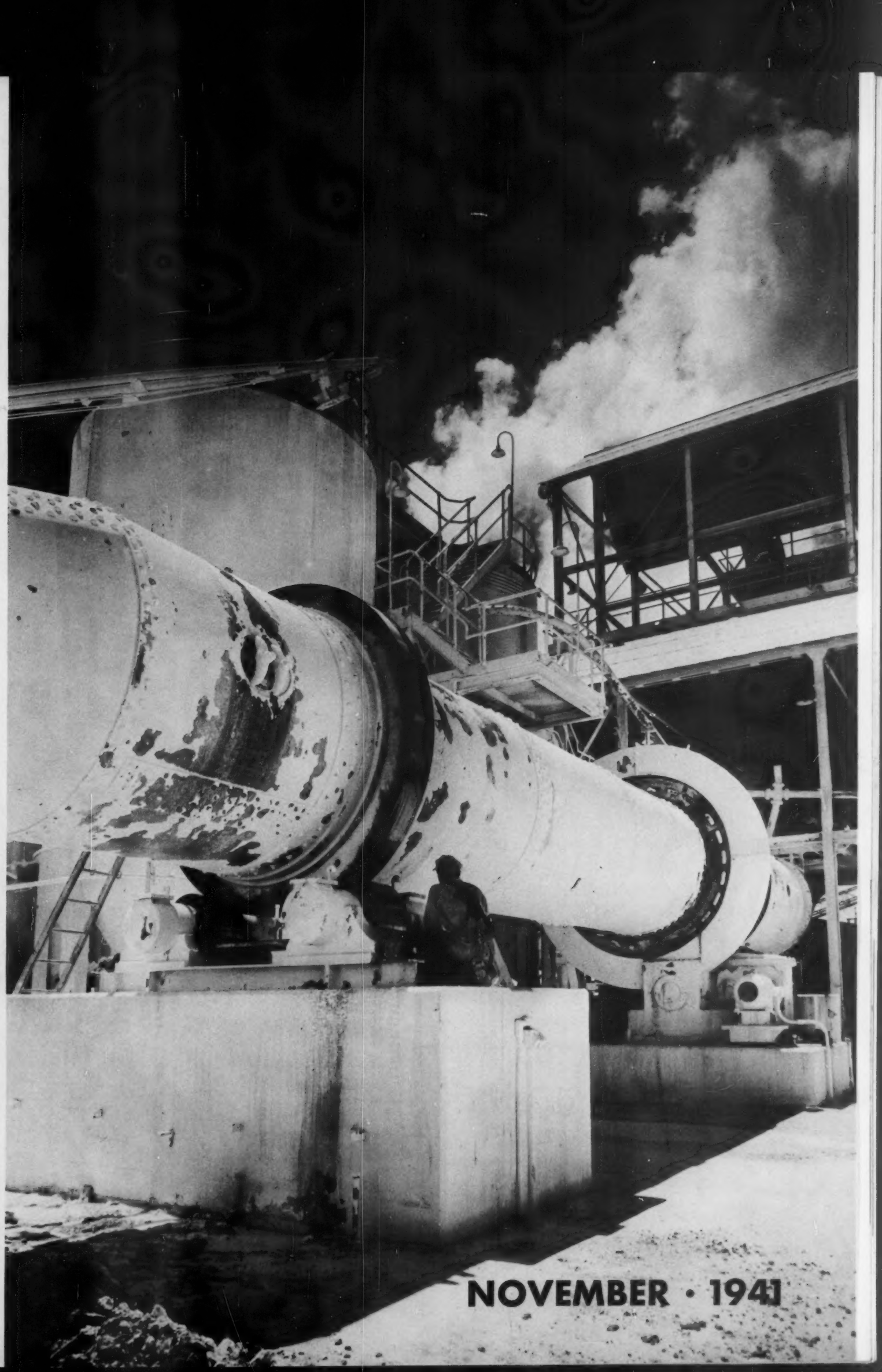
TECH ENGINEERING NEWS



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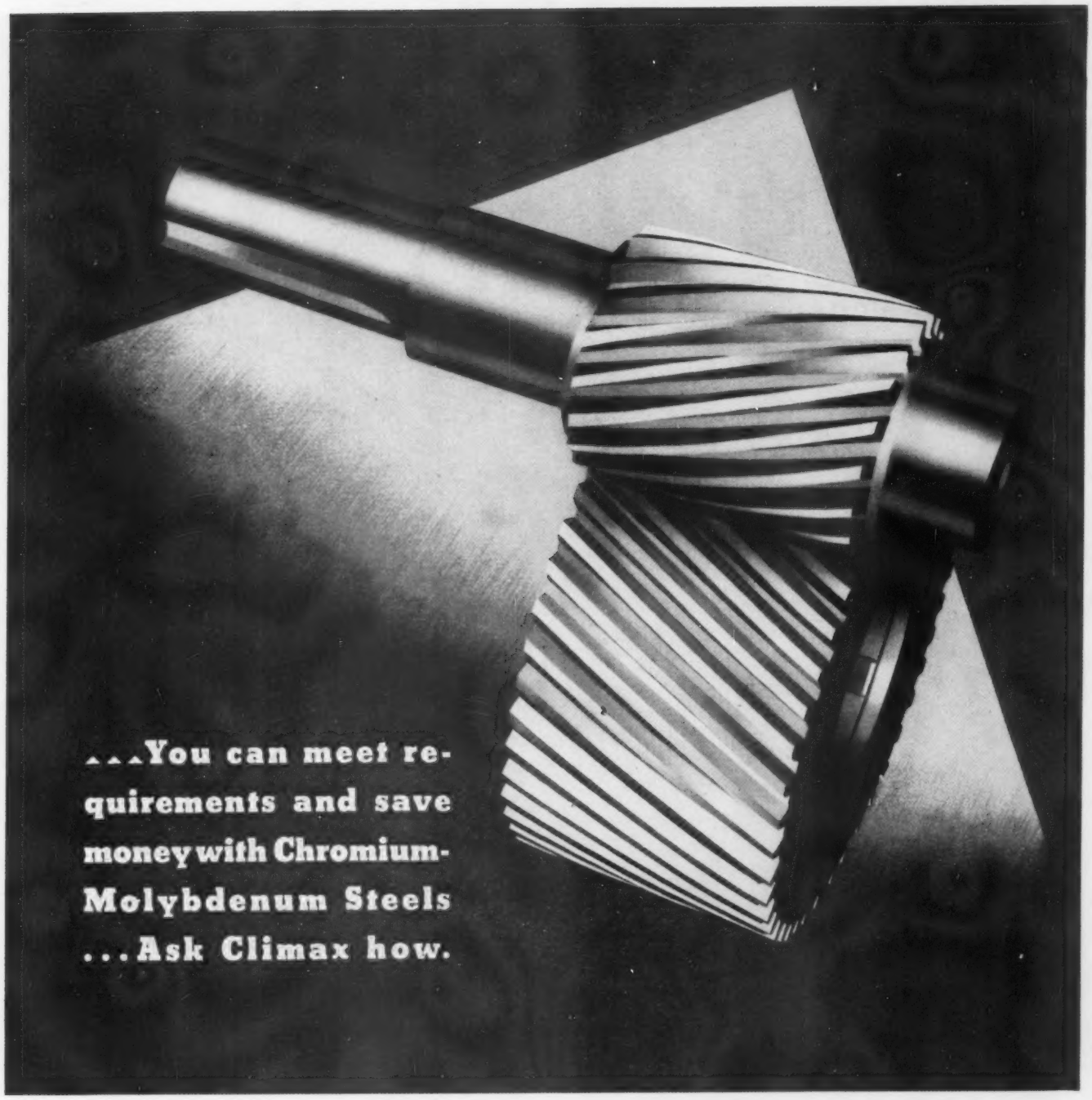

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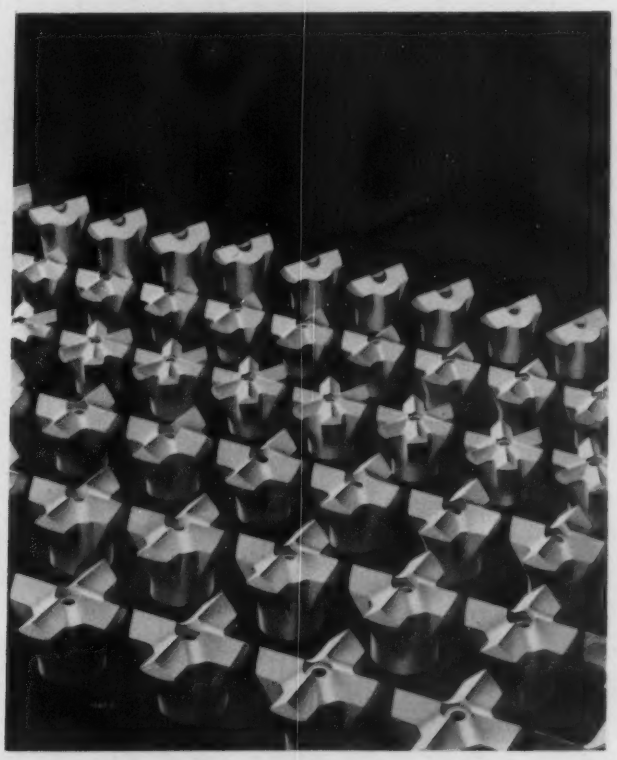

VOLUME XXII NUMBER 6

• CONTENTS •

ARTICLES

131 THE PILOT PLANT — R. B. SEMPLE
Where new chemicals grow

133 WIND POWER — PROF. JOHN B. WILBUR
Will the 175 foot windmill on Grandpa's Knob provide an efficient source of electricity?

134 HARNESSING THE SUN — JOHN A. SIBLEY '43
How M. I. T. is attacking the problem of an ever decreasing world fuel supply

138 99 44/100% PURE — ALAN S. MICHAELS '44
The soap industry relies on the research of the chemist

141 PRIORITIES UNEMPLOYMENT — ROBERT V. BARTZ '44
A rising national problem requires a technological as well as political solution

FRANKLY SPEAKING

144 THE MINUTE MEN OF '41 ARE READY

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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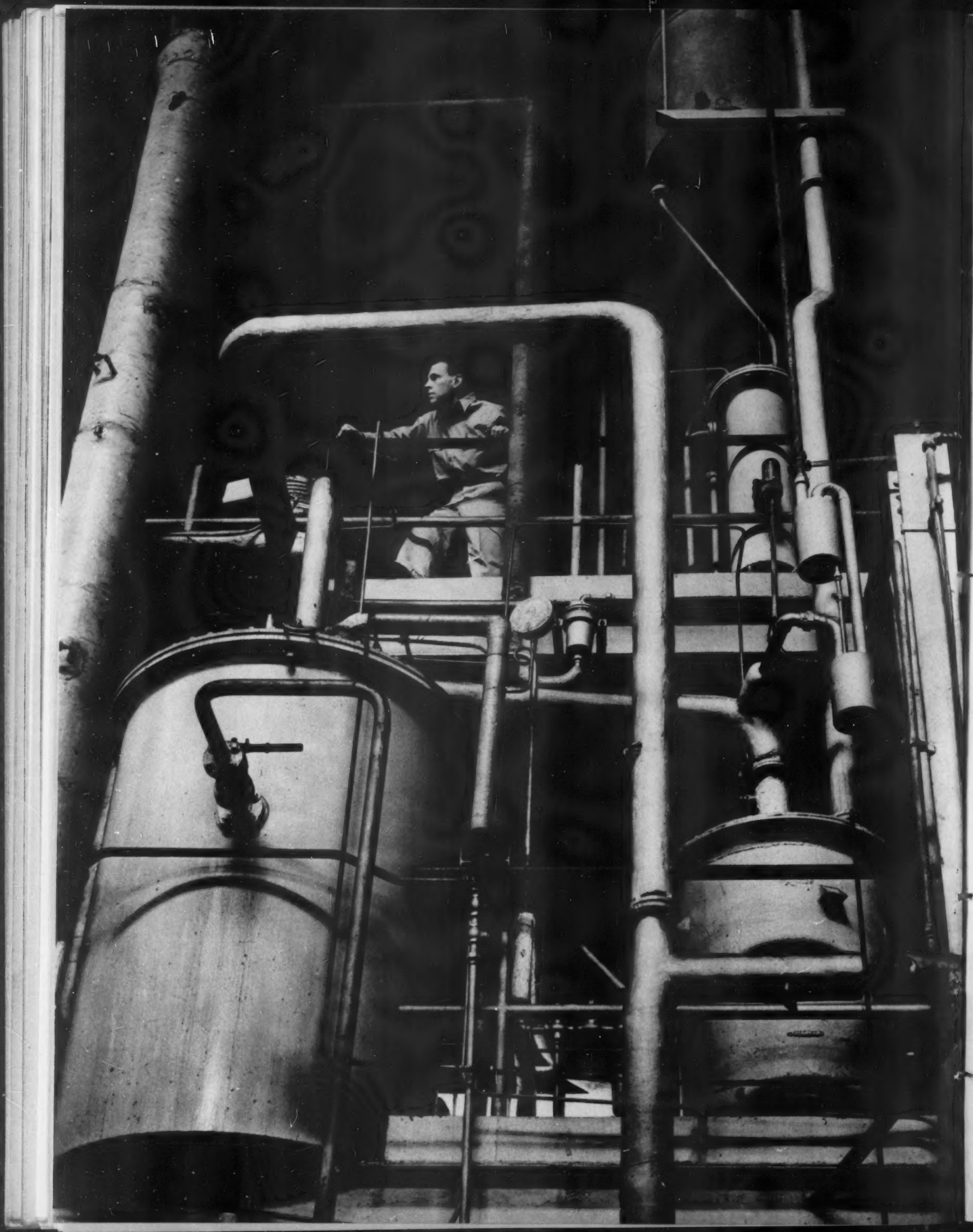


THE PILOT PLANT

WHERE NEW CHEMICALS GROW

By R. B. SEMPLE
MONSANTO CHEMICAL COMPANY

Monsanto's Assistant Director of Development, Mr. R. B. Semple, is a Massachusetts Institute of Technology graduate in chemical engineering. Pilot plant procedure and conduct were under his immediate supervision for several years and during that time he exhibited the qualities of leadership and initiative that made him fit for the position of Assistant Director of Development. Mr. Semple's rise in the few years that he has been in business is a definite challenge to other Tech engineers.

CHEMICAL progress is no miracle. To the lay mind, the amazing new chemical developments, including vitamins, hormones, plastic materials, synthetic rubbers and a host of others, which are headlined in the news today, spring full blown from the test tube stage to large manufacturing plants, and thence to the ultimate customer. While it is true that all basic work is carried out in the laboratory, where the research chemist can work out his process on a small scale in glassware, and under conditions where he can control his reaction and perform the greatest possible amount of work in a short time, a new product or process is not ready for large scale manufacture until it has gone through a further proving ground on a still larger scale. To do this a small plant is designed to simulate as closely as possible conditions under which the process is expected to eventually operate.

This step is called pilot plant, or half large scale, operation, and the pilot plant assumes particular importance in the chemical industry, producing as it does, an endless stream of new and better materials for both industrial and civilian needs. The surprising progress of the chemical industry in the United States since the turn of the century has been no miracle, and is due chiefly to the willingness of farsighted management to give free reign to creative research. This industry spends more of its earnings on research than any other, and it is estimated that over $250,000,000 per year is now being spent in this country on chemical research. Pilot plant work undoubtedly accounts for a sizeable portion of this huge sum.

The pilot plant is primarily conceived as the proving grounds for new processes, and may deal either with the modification of a present manufacturing process for an established product, with the development of a new process for an established product, or with the development of a process for a new product for which the market may have to be established. Many questions must be answered that cannot adequately be tackled in the laboratory, in order to furnish the designing engineers with data upon which to base plans for a full scale manufacturing unit; the most efficient types of equipment must be determined, materials of construction selected, engineering data collected, such as heating and cooling loads and power requirements, operating information determined, including time cycles and labor requirements, and the quality of the finished product established and proved under operating conditions.

Secondly, the pilot plant often provides the most practical and efficient way of handling initial manufacture of new products during the preliminary marketing stages, and until sales volume justifies erection of a full scale plant. In the complement of more or less permanent but flexible equipment the manufacture of new products can be handled on very short notice and with a minimum of change. Thus Monsanto was able to produce sulfanilamide for an urgent market within a few short weeks after initial work was started in the laboratory. Here was an instance where an almost unlimited market existed and the paramount need was manufacture. On the other hand, the development of pentachlorophenol as an industrial preservative required a considerable period of market development work, and is one where concurrent pilot plant manufacture was carried out for an appreciable time before a full scale plant was justified.

As a result, the pilot plant has assumed increasing importance, and in most of the larger chemical companies it is a completely integrated department, working closely with both research and production. Each

Conducting laboratory experiments parallel to pilot plant operation

Opposite page . . . ***Typical pilot plant set-up.***

Digging a pilot plant centrifugal

of the several divisions of Monsanto has such a department, with its own staff of chemists and chemical engineers, foremen, operators and mechanics. In effect the pilot units are miniature plants, operating under similar conditions to full scale operations, twenty-four hours a day, and usually seven days a week.

Thus the pilot plant, being a halfway stage in the development of a chemical process, combines many features of both research and production. Let us see, therefore, what the pilot plant chemist is likely to cover in the course of his job. Starting from scratch, this chemist's first step is probably the design of a miniature plant, based on the data obtained in the laboratory, and in coöperation with the mechanical engineers who handle actual installation of the equipment. Here he has an opportunity to interpret research data and to train himself in forecasting future operations. Next the pilot plant is erected. Here the chemist has an opportunity to watch and to check the installation, making any necessary suggestions as they may occur to him.

In the operation of the pilot plant, the chemist plans his miniature production, raw materials are ordered, labor is scheduled, operating instructions are prepared and finished materials moved. At this time the plant supervisor, who ultimately takes over the process, becomes interested and maintains close contact with the pilot work. In this way the chemist has an opportunity to obtain experience from these operating men. Ingenuity in the clever solution of mechanical problems is vital, and from the beginning of a demonstration until its conclusion there are many chances to straighten out the inevitable kinks that develop. The pilot plant chemist has an opportunity to suggest and make improvements in the original process, and here is his real chance for creative thinking. Yields are seldom quantitative, time cycles are often longer than necessary and usually there are improvements which can be made in the quality of the finished goods. Pilot plant work almost always introduces some variations in product quality, and this is one of the most important things to clarify before going to the large scale.

Should it be desirable to continue production of a new product for sales purposes following the initial demonstration, the pilot plant chemist has an opportunity not only to continue improving his process, but also to parallel the role of a production supervisor, producing material on schedule for sales.

When pilot plant demonstration has been completed the chemist coöperates in the design of the large scale plant, working with the designing engineers and the production supervisor. A process is literally transferred from the laboratory to the manufacturing department on the shoulders of the pilot plant chemist.

Obviously, pilot plant work calls for highly trained men with initiative and ability. Pilot plant chemists must be very carefully chosen and usually are selected from men experienced in either production or research, preferably both. It does not necessarily follow that there is a fixed group in the pilot plant to handle this phase of the work, for nearly always research chemists follow their projects in some phases into the pilot plant and through the various steps enumerated above, and even into plant operations. In general, however, a research chemist's talents lie more along the lines of strictly laboratory work, and it is the chemical engineer that does the major share of the pilot plant work. However, as in all phases of successful chemical manufacturing, a finished product is the result of coöperative effort rather than one of individual genius.

In the last analysis, pilot plant work provides an excellent opportunity to develop executive ability. A successful pilot plant chemist must be able to look all around his problem with a long range point of view and with prospective. He must be able to plan not only his own time but the time of his assisting foremen and operators. Above all things he must be able to get along with others in his many contacts with research chemists, production men and engineers. He must have a natural drive that pushes through difficult assignments, with the never ending string of problems that always face him. Pilot plant work is, indeed, one of the most vital phases of the chemical business and provides a true challenge for chemists and chemical engineers with initiative and ability.

WIND POWER

WILL THE 175 FOOT WINDMILL ON GRANDPA'S KNOB PROVIDE AN EFFICIENT SOURCE OF ELECTRICITY?

By PROF. JOHN B. WILBUR

ASSOCIATE PROFESSOR OF STRUCTURAL ENGINEERING
CHIEF ENGINEER OF THE WIND TURBINE PROJECT

THE wind turbine which is just being completed on Grandpa's Knob near Rutland, Vermont, is in reality a large scale research project. It has been built as an attempt to find out whether it is possible to convert the power of the winds into electrical energy economically and on a large scale.

The development of electrical energy from the winds is not in itself new. In recent years a larger number of farm units have been installed. These units are operating successfully, but they develop direct current and depend on storage batteries to act as a means of storing power for periods of low winds. Farm units are used to develop electrical energy in localities where power cannot be purchased from existing utility companies. Hence, the cost of power so developed need not compete with other methods of developing electrical power on a large scale.

The power developed by the Smith-Putnam Wind Turbine will be in the form of alternating current, to be supplied directly into the lines of the Central Vermont Public Service Corporation system. From the point of view of economics, it must compete with the development of similar energy by steam or hydro-electric plants. In order that this competition may be successful, estimates have shown that it is necessary to have a very much larger unit than those used for farm installations. The test unit on Grandpa's Knob has a blade diameter of 175 feet and a generating capacity of 1,000 kilowatts. The unit will develop power only when the wind is blowing. As designed, it will require a wind velocity of about 18 miles per hour before any power is developed. It is therefore necessary to consider the energy which may be developed by this installation as secondary energy, although the amount of this secondary energy to be developed in a given period of time is, to a large degree, predictable. It is necessary to think of the power which may be obtained as predictable secondary energy, in order to estimate its value to an existing power system.

It is hoped that the installation on Grandpa's Knob will perform the following functions:

1. Demonstrate that the unit will perform satisfactorily from the structural, mechanical and electrical points of view, so that energy which will be of value to a utility system, can be developed during variable wind conditions.

2. Furnish data which (*Continued on page 156*)

The wind turbine with its stainless steel blades in place

Sun laboratory where the plan to heat a building by solar energy is being put to test

HARNESSING THE SUN

HOW M. I. T. IS ATTACKING THE PROBLEM OF AN EVER DECREASING WORLD FUEL SUPPLY

By JOHN A. SIBLEY '43

As man's society becomes more and more complex, his energy requirements increase at an immense rate. The cave man, whose only need was about two thousand calories of food a day, used the equivalent of about one-half pound of good-grade bituminous coal per day, or about two hundred pounds per year. Yet a modern man, living in the midst of thousands of mechanical devices which required energy both in their manufacture and use, consumes over ten tons of equivalent coal a year, or over a hundred times the energy actually needed by the body. This rate is constantly increasing; the last sixty years, during which America has changed from a young agricultural nation to the most highly industrialized nation in the world, have seen this country's fuel requirements increase sixfold. As technological advances are being made every day, there is little doubt that an even greater supply of energy will be needed in the future.

The sources of energy have likewise changed. During this same sixty year period, wood has declined in importance from 60 per cent of the total to only six per cent. Coal rose to a peak of about 80 per cent in 1918 and then decreased due to the development of the oil industry. At the present time anthracite and bi u-minous coal supply about 45 per cent of the total; petroleum and natural gas supply about 36 per cent; water power supplies about 10 per cent; and the small remainder is furnished by wood, food, and wind. With the exception of wind and water, the supplies of these materials are being rapidly depleted, and, although the problem at present is far from urgent, they may eventually be entirely used up.

For many years scientists have realized the need of developing a new source of fuel and have been considering the possibility of employing the vast amount of energy which is constantly being received from the sun.

The earth and its atmosphere intercept the equivalent of twenty-one billion tons of good coal per hour, which means that in three minutes enough energy is received to equal America's consumption for one year. In the past many devices have been built in an attempt to tap this immense flow of power, yet the results of these early experiments have been unrelated and undecisive. These inventions worked with varying degrees of success, but, until two years ago when Dr. Godfrey Cabot's gifts to Harvard and M. I. T. made possible the establishment of research programs at the two schools, no scientific inquiry into the basic problems of solar energy conservation had been made. The Harvard group is primarily concerned with an investigation of the chemistry of photosynthesis, while a committee of the Institute is studying the physical problems of energy collection and utilization.

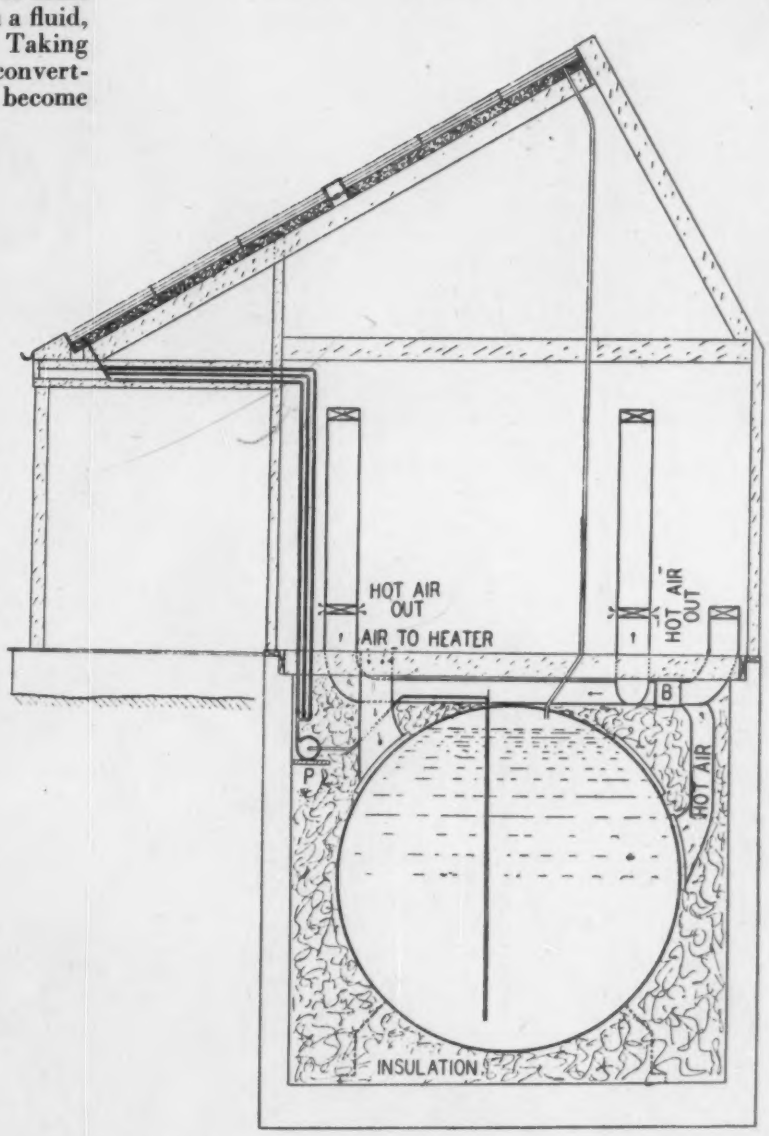
Before proceeding further with a discussion of solar power perhaps it would be well to destroy the optimistic picture which is given by the above figures of the amount of solar energy available. They are based on the amount received per acre of surface at a point outside the earth's atmosphere and normal to the sun's rays, which energy at noon reaches a total of about 7,500 horsepower. Of this power only about 5,000 horsepower reaches the surface of the earth. If this energy is used to operate a heat engine, allowance must be made for the efficiency of collection as heat in a fluid, and the energy rate drops to 3,300 horsepower. Taking the highest attained value for the efficiency of converting such heat to useful power, the horsepower become only 490.

Thus far the calculations have been based upon sunlight normal to the surface of the collector. If the collecting system is mounted to follow the sun in order to fulfill this condition, the different units of the system must be separated so that they do not shade each other during part of the day. Allowing a ground coverage factor of one-third, the horsepower is cut to 163. Converting this figure to power over a twenty-four hour period in summer in Arizona, the output becomes 83, or in winter 68 horsepower. Finally, considering the average number of clear days in New York the actual horsepower per acre is 50, only one one hundred and fiftieth of the initial figure.

One may evaluate this answer in terms of dollars and cents and hence roughly determine the economic feasibility of employing solar power. Assuming that electrical power can be produced in a large modern plant at .6 cents per kilowatt hour, or $53 per kilowatt year, the output of a one acre plant is worth $1,900 a year. Figures on labor costs and maintenance are lacking, but optimistically assuming a high capitalization of 15 per cent, there is $13,000 to spend on the entire plant, or $2.60 per square yard. As ground coverage was only one-third, $8.00 are available to construct each square yard of reflectors, mountings, and accessories. This value is quite low and shows how slim the margin of profit is at present on a solar energy plant. It is evident that the degree to which solar power is to be utilized in the future depends upon the increase of these efficiencies, and it is toward this end that the research is being devoted.

The first project in M. I. T.'s solar research program is the study of different types of collectors and the development of one with the highest possible efficiency. The type of collector which has been perfected to the greatest degree is the simple flat-plate type. It consists of a sheet of metal, or a body of some other material such as water, sulphur dioxide, or even sand which is heated by the sunlight. The bottom side of the plate is insulated and the top side is covered by a sheet of glass parallel to it with about an inch of air space between. When thus covered the plate receives practically as much sunlight as before, the glass transmitting about ninety per cent, but the losses from the plate to the atmosphere are greatly reduced, the convection losses being eliminated due to forced stagnation of the air, and the radiation losses being eliminated because the glass, although transparent to the sun's rays, is opaque to the long-wave infra-red radiation emitted by the hot plate. Variations in this design include having vacuum spaces instead of dead air spaces, and employing several glass plates instead of one.

As each additional layer of glass cuts down the losses, one would suspect that with sufficient layers a perfect collector could be built, yet this is not the case. It is true that if the right glass is chosen there will be little absorption of the sunlight, but there is a reflection



Sectional view of solar energy building at Technology

loss of about four per cent at each surface. Consequently, as one adds more plates, one ultimately reaches a point where the reduction in heat loss from the metal plate is more than offset by the reduction in intensity of incident radiation due to reflection losses. This optimum number of plates varies, being less the greater the sun and more the colder the weather or the hotter the plate.

It was in order to decrease these losses through reflection that the process of coating glass was developed by Dr. Turner and Dr. Cartwright whereby the glass has a permanent surface of reflectivity approaching zero at one point of the spectrum. This important discovery has already proven valuable in many other fields, ranging from spectacle lenses to bomb sights. As yet the special glass has not been used in an experimental solar energy collector, but calculations indicate that its use should make possible the attainment of 800° F. without the use of a mirror, lenses, or other concentrating devices.

A second problem in designing flat-plate collectors is that of optimum tilt. Because of the simplicity of the design, it is more economical to have the collectors mounted at a permanent tilt than to have them follow the sun. The angle of tilt depends very definitely on the use to which the collected heat is to be put. If the purpose is the maximum collection of heat during the entire year, tilting should favor the summer months. If, however, the object is to supply heat for a load which varies during the year, the tilt should favor the part of the year during which the load is the greatest.

Of the many uses to which such collectors may be put, perhaps the simplest is the heating of a house in a relatively cold but sunny climate. The system would consist of a well insulated tank from which water can be pumped to the collector and back whenever the collector is hotter than the tank, and a set of radiators through which the hot water could be circulated to heat the building. It was for research into this type of heating that the cottage was built on the M. I. T. grounds. For many months the plan has been put to a practical test, and valuable data are being obtained on the optimum number of glass plates, the best tilt, the ratio of roof to tank area, and the advisability of employing special types of glass.

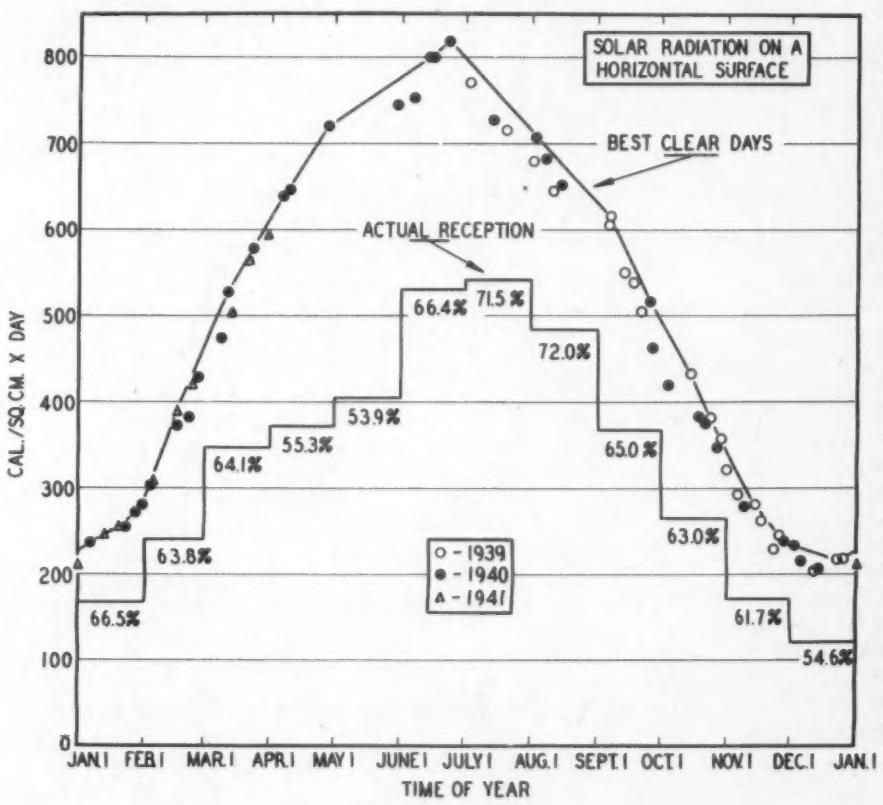
Another obvious use is the employment of the sun's heat to run a steam engine, a hot-air engine, or similar device which requires a heat reservoir. The cost of power production in a conventional plant depends enormously upon the size of the plant, and, therefore, although the efficiency of solar power plants is small compared to large conventional plants, it nearly equals the efficiency of very small plants. It is not unreasonable to hope that future large solar energy converters will make power as cheaply as a fuel-fed plant.

In order to obtain efficiency in small solar plants another type of heat engine is being developed, the thermopile. When two dissimilar, conducting materials are joined to form a loop and the junctions kept at different temperatures, heat flows into the loop at the hot junction, a portion of its energy is converted into electrical energy, and the rest flows out as heat at the cold junction. This principle of thermo-electricity has long been known, and the possibility of electrical power production on a large scale by this method has often been considered and always dismissed because the effect is very small. As the result of recent research the overall efficiency of the best thermopile is about four per cent, but it is possible that intensive research will increase this value several fold. As the efficiency of the best steam power plants is only 25 per cent, a small converter with an efficiency of five per cent would be of great value. It is toward the development of more effective thermopiles that the second branch of the M. I. T. research program is directed.

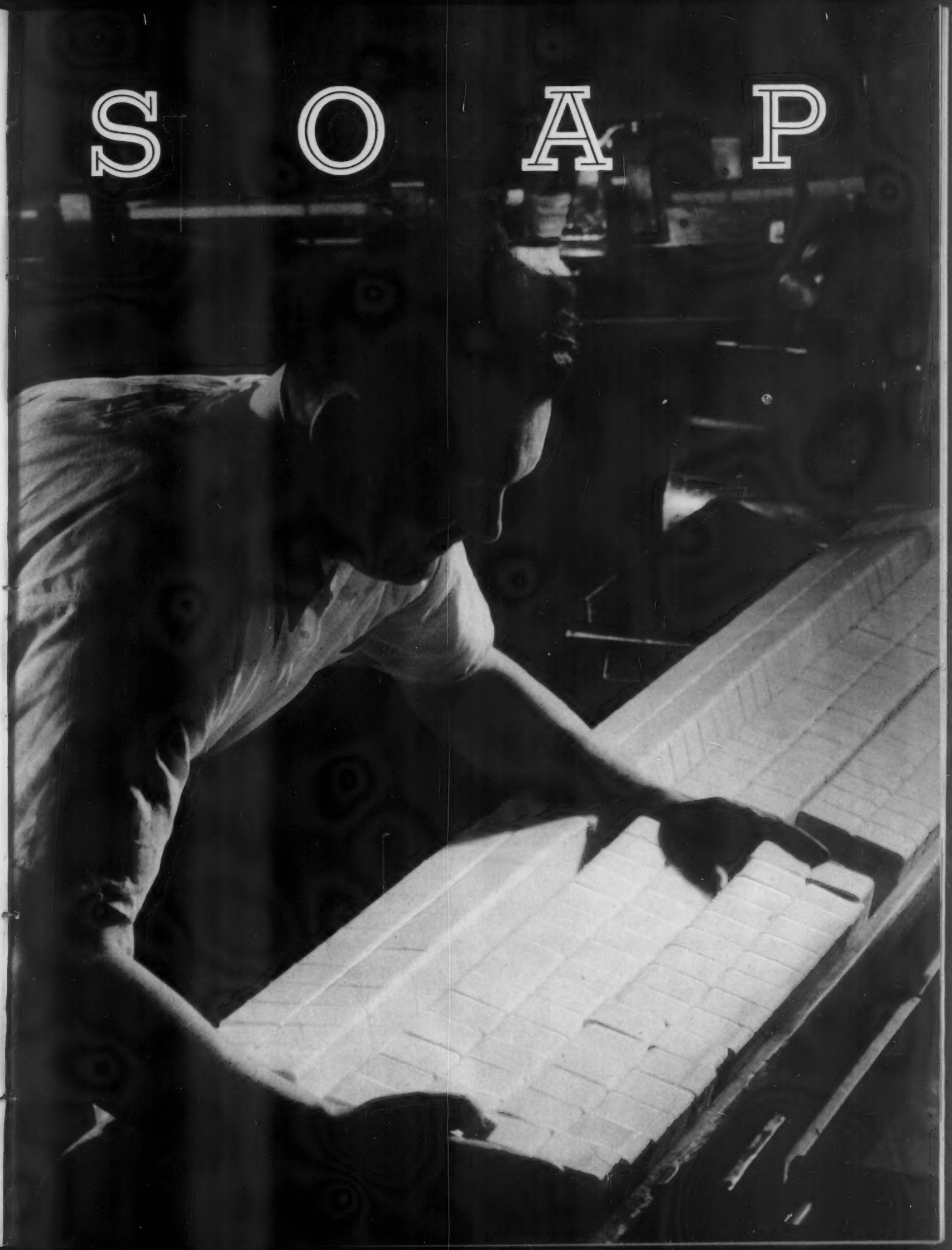
In order to form an effective couple, the two metals must have, in addition to high thermo-electric power, a low thermal conductivity in order to minimize the loss of heat flowing from the hot to the cold junction, and a high electrical conductivity so that there will be little resistance losses. The ratio of thermal to electrical conductivity is known as the Weidemann-Franz ratio, and it is desirous to have this value as low as possible. Experiments have shown that alloys of zinc and antimony have a surprisingly low Weidemann-Franz ratio while retaining a high thermo-electric power. By using an alloy of 43 per cent zinc in antimony against a copel alloy with a temperature difference of 400° C., a moderately effective engine is formed.

Thus far, only the so-called heat engines have been discussed. Both steam engines and thermocouples are devices which receive energy at a certain temperature, convert part of this energy to useful power, and throw away the rest to a so-called heat sink at a lower temperature, and, therefore, their efficiency is limited by the Second Law of Thermodynamics. It is this law which states that the efficiency of a heat engine cannot be greater than the difference of the initial and final temperatures divided by the initial temperature, that was the reason for the sudden reduction of the value of solar power from 3,300 to only 490 horsepower. As high (*Continued on page 146*)

Comparison of actual reception of solar heat in collectors at Cambridge with incidence of solar energy on best clear days

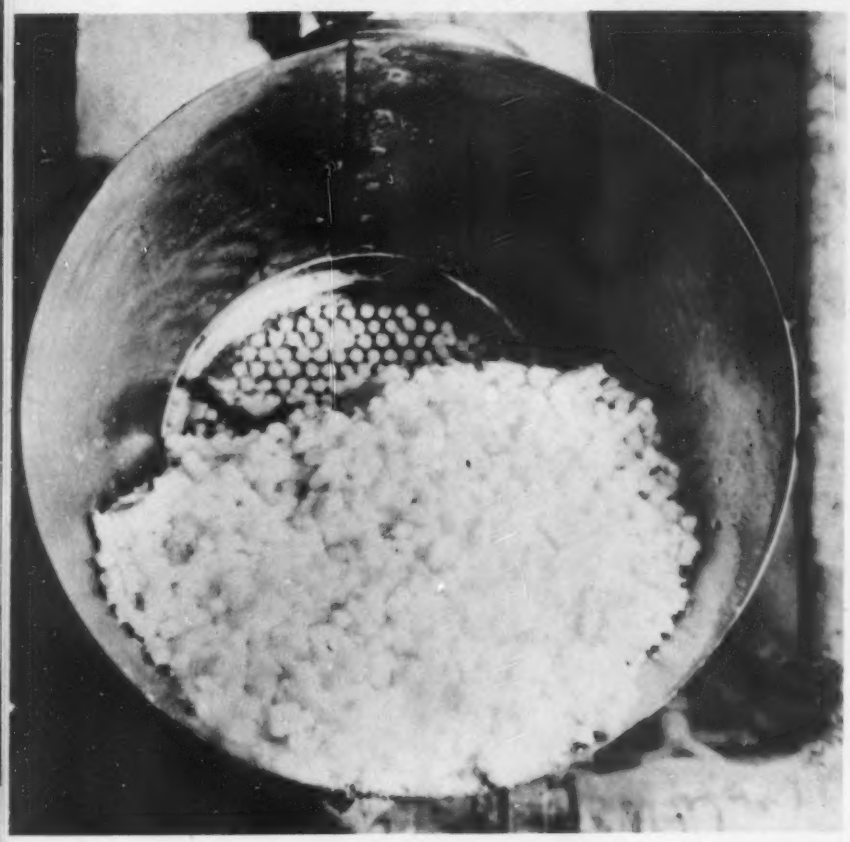


S O A P



Soap is shaved into thin strips

Mixing flakes of soap before pressing into bars



Left. *Scraping down 1000 pound frame of ivory before it is slabbed and then cut into cakes.*

Right. *A keyboard of ivory slabs are cut into cakes by piano wires.*

$99^{44}/_{100}\%$ PURE . .

THE SOAP INDUSTRY relies on research of the chemist

By ALAN S. MICHAELS, '44

SOAP has come to be such a commonplace item in modern civilization that it has seldom been looked upon with technical curiosity. The automobile, airplane, radio, and other scientific achievements of the age are constantly investigated by scientific writers because they are dynamic industries — subject to change from day to day. Curiously enough, although we accept soap as a static article of commerce, its manufacture is equally as dynamic as more recent technical accomplishments. Constantly improvements are being made in soaps, or more accurately, detergents. Soap must serve an infinite number of purposes, all the way from the heaviest industrial processes to the simplest home uses. There are certain characteristics in soaps that each of these purposes demands. Obviously, the properties of a soap used for cleaning bristles in a hair brush factory would hardly be the same as those required of a soap for washing fine woolens. This is an extreme example, but nearly every detergent is made to serve its own, individual purpose.

Chemically, soap is the salt of an inorganic base and a fatty acid. In industry it is manufactured by the reaction of a fatty acid ester (usually a glyceryl ester) with sodium hydroxide or sodium carbonate. The reaction might be compared to the "formation of a weak base" in inorganic chemistry. The products are a soap and glycerine. The esters are obtained from animal and vegetable tissues, such substances as animal fat, olive oil, palm oil, cottonseed oil, and coconut oil being typical examples. In chemical language, a reaction might take place as follows:

$$C_3H_5(C_{18}H_{33}O_2)_3 + 3NaOH = 3Na(C_{18}H_{33}O_2) + C_3H_5(OH)_3$$

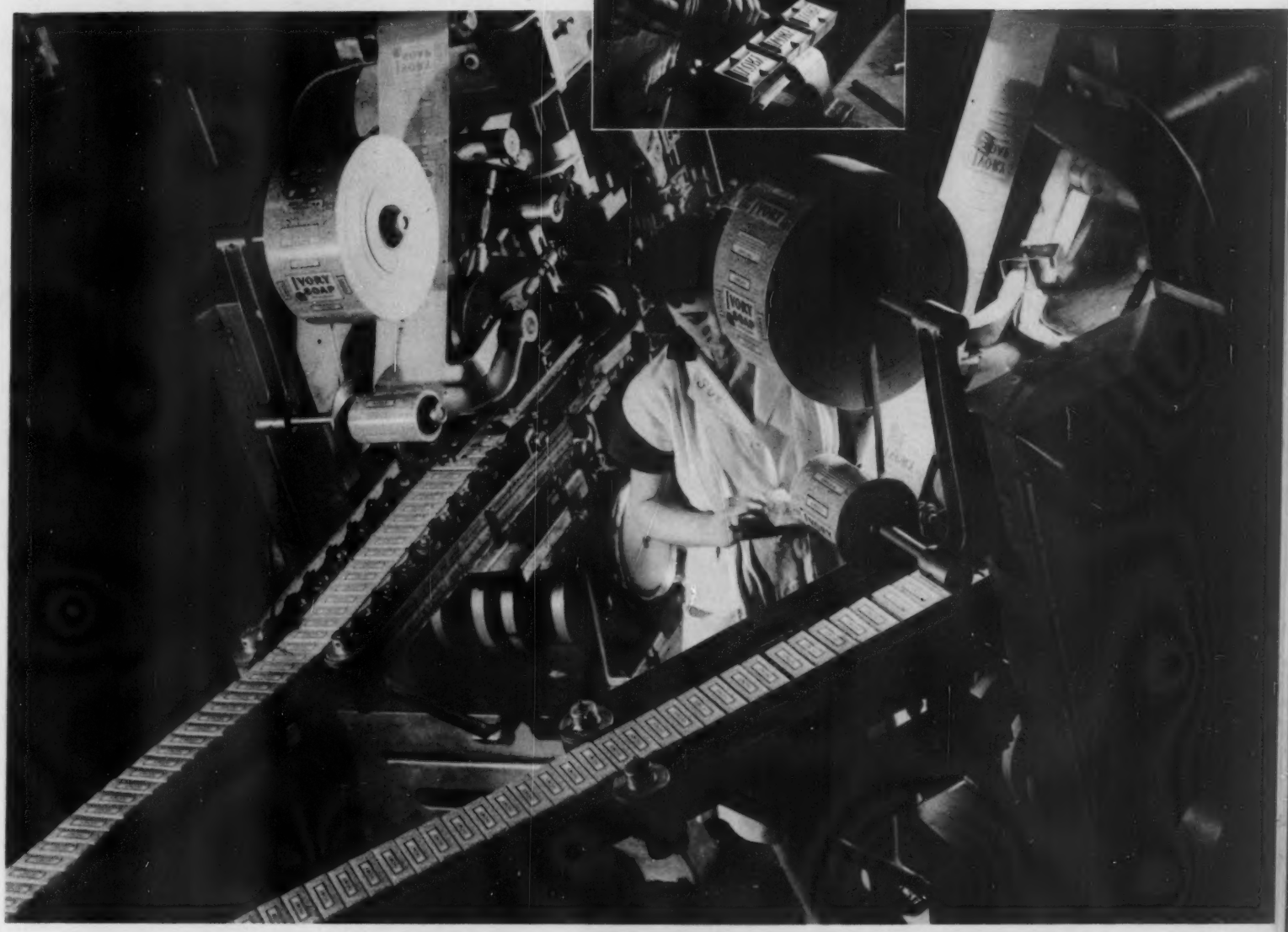
Here the ester is olein, and the soap formed is sodium oleate. The glycerine is tapped off, and the soap is allowed to cool and harden.

Actually, oils and fats are complex compounds and mixtures, but consist mainly of the esters olein, palmitin, and stearin. In the process of saponification many complicated reactions undoubtedly take place, the one mentioned above being one of the simplest. In general, a soap is referred to as a compound of the structure $R-COONa$, where R represents one of many hydrocarbon chains. Sodium oleate, written in this manner, would look like this: $C_{17}H_{33}-COONa$. This notation is extremely helpful in explaining the action of soap on water and its cleansing properties, and will be used shortly for that purpose.

In large scale production, the oils or fats and soda are combined in huge, steam-heated kettles carrying up to 300,000 pounds of material at one time. With live steam bubbling through the mixture, the kettle is left for two days. At the end of this period the soap and glycerine mixture is subjected to an operation known as "graining" or "salting out." Several tons of common salt are shoveled into the kettle, and the soap, heretofore in colloidal suspension with the glycerine and water, coagulates and comes to the surface. The liquid or "spent lye" below is tapped off and purified to obtain

Right. ***Burnishing the dies from which the soap is stamped***

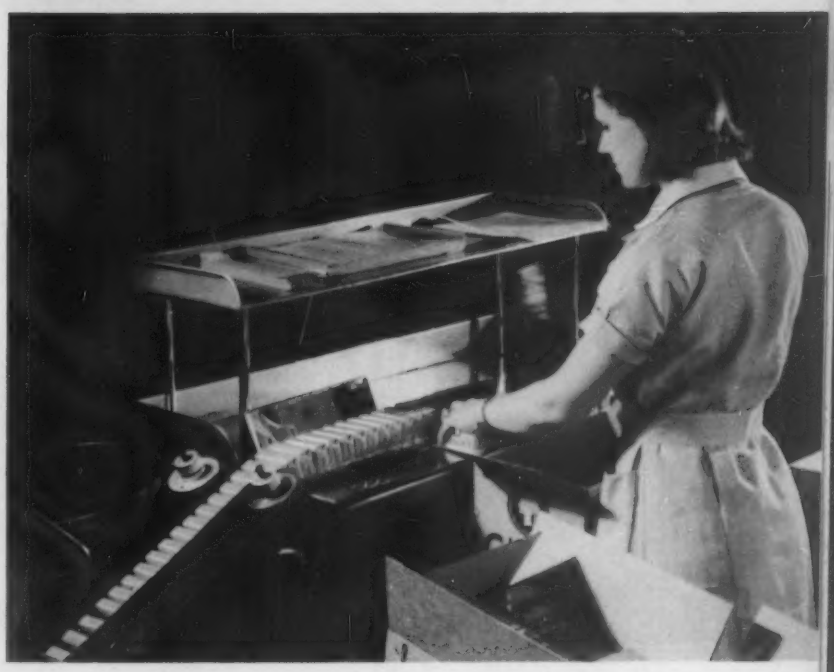
Below. ***Heat-sealed wrappers roll on the cakes***



the valuable glycerine. The "curd" or soap may then be dipped out, cooled, and allowed to solidify. Such curd soaps, however, contain glycerine, salt, lye, and many other impurities. To prepare a purer soap, the curd is mixed with brine, allowed to separate, the liquid removed, and the process repeated as often as necessary. After the brine treatments, a little water is added to the soap, the mixture heated, and again allowed to settle. The upper layer of this solution contains the purest soap, most of the foreign matter having been removed by washing.

The liquid soap is then run into frames and allowed to harden and "age." After this, all that remains to be done is trimming, cutting, stamping, and packaging. The soap is then ready for the market.

Such soap often is specially treated to give it varying properties. Floating soap is made by beating air into the liquid mass. Laundry soaps and strong clean-



. . . and into the shipping cartons

All pictures courtesy Procter & Gamble

ing soaps may contain free alkali in the form of sodium carbonate, borax, or sodium silicate. Soap powders are sometimes made from ground soap and sodium carbonate. Scouring soaps contain fine sand or pumice. Soap can be made transparent by the addition of alcohol, glycerine, or sugar.

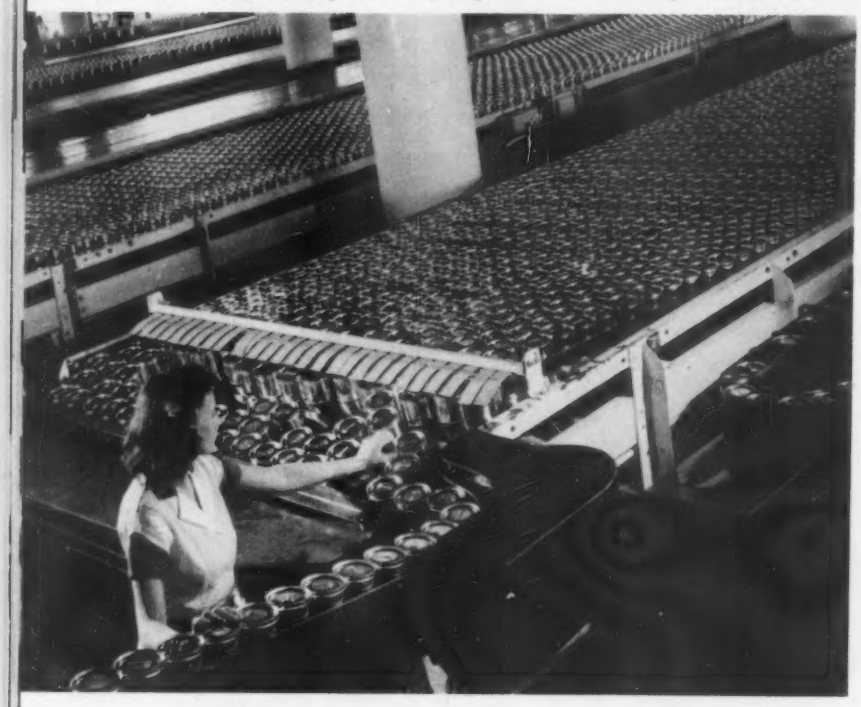
The "hard milled" soaps, such as are used for medicinal and cosmetic purposes, undergo a slightly different processing. The liquid soap is first mixed thoroughly, pressed paper-thin between cold rolls, and broken into flakes. It is then compressed into pellets, mixed with perfume, and squeezed into a cylinder by polished granite rollers. The cylinder is cut into short lengths and stamped. Such soap is very hard, very dense, and very attractive to the eye. Because of its compactness it dissolves more slowly and lasts longer than an ordinary cake of the same size.

The soap industry is a varied and extensive one. About two and one-half billions of pounds of soap are produced annually in the United States. One of the largest companies in the field, Procter & Gamble, manufactures nearly everything from shampoos to dentifrices. By hydrogenation of cottonseed oil, vegetable shortening is made. As cottonseed oil is an ingredient in soaps, it is not strange to find the soap industry entering into the production of foodstuffs. Yet soap products are not found only in the drug or grocery store. Wherever there is washing with water to be done, there is soap, or its equivalent, to do the work.

An interesting problem for the physical chemist is, "What makes soap soapy?" or "Why does soap remove dirt and grease?" Many plausible explanations have been given, and the following is but one interesting example.

When soap is "dissolved" in water, the freezing point of the solution is lowered, but not nearly as much as would be true of a highly ionized salt. Experiments seem to indicate that a soap solution is very largely a colloidal suspension. Indeed, the fact that soap is curdled out of solution during its manufacture by the addition of a highly ionized salt is good evidence of its being a colloid. As mentioned before, the general formula for a soap is R−COONa, where R represents a long hydrocarbon chain. In water solution, the soap molecule is supposed to break up into two, or actually three, parts. The first is the non-polar hydrocarbon R−. The second is the partially polar −COONa. This polar "tail piece" tends to go into true solution forming the ions $-COO^-$ and Na^+. The non-polar R−, on the other hand, has little or no tendency to go into solution, any more than the original oil or fat has. In fact, the hydrocarbon tries to remove itself as far from the aqueous medium as possible — namely, to the surface. The two opposite forces, one pulling outward, the other pulling inward toward the center of the solution, result in the formation of a semi-ionic structure called an "ionic micelle."

One of the soap industry's many side lines, the manufacture of vegetable shortening. *Procter & Gamble*



At the surface of a soap solution, the polar −COONa is attracted inwards, and the non-polar R− is repelled outwards. Thus the surface actually consists of a solid film of hydrocarbon molecules. The surface tension of such a solution is therefore much lower than that of water. It is rather that of the oil represented by the hydrocarbon R−. It is to this phenomenon that soap owes its properties as an *emulsifying agent.* If oil is mixed with water and the mixture violently shaken, the oil disperses through the water in small droplets, but as soon as the mixture is left standing, the liquids begin to separate. If oil is mixed with a soap solution, a surface comes in contact with each droplet of oil. Since this surface is essentially an oil due to the aggregation of hydrocarbon molecules from the soap, the rigid film formed at the junction of the two non-miscible liquids makes separation extremely difficult. For this reason, soap can remove grease and oil from materials. The oil is broken into droplets, surrounded by soap film, and washed off.

The ability of soap to remove grit or soot is due to its colloidal properties. The interior of a soap solution contains largely unionized particles in suspension. When brought in contact with finely divided inert material, the soap suspension absorbs it into the solution.

These two properties — emulsification and absorption — make soap a good detergent or cleaning agent. Yet soap has some very bad and troublesome characteristics. In acid solution, the fatty acid is precipitated from a soap: $R-COONa+HCl=NaCl+R-COOH$. In the presence of solutions of the heavier metals, gummy, slimy insoluble soaps are thrown down: $2R-COONa+CaCl_2=2NaCl+(R-COO)_2Ca$. These insoluble soaps stick to and discolor clothes, fill up pipes, cling to utensils, and make cleaning annoying, if not practically impossible. Millions of dollars have been spent in development of methods for softening hard water and thus avoiding the waste and nuisance incurred by such precipitation. Sodium carbonate has been used with soap to precipitate the powdery carbonates of the heavy metals in preference to the insoluble soaps. The well-known Permutit process has proved successful in softening hard water on a large scale. Many other processes have been devised for this purpose, all of which have proved satisfactory, but today chemists are trying to correct, not *the solvent*, but the *solute.*

"Soap," that is, the metallic salt of a fatty acid, is no longer alone as a cleaning and wetting agent. The chemist has found equivalent substitutes that do not have the undesirable qualities of soap. These detergents belong to a group commonly known as "hymolal salts" and "long-chain alcohols." They have the same emulsification and absorption properties of soap, but are chemically quite different. (*Continued on page 148*)

A RISING NATIONAL PROBLEM REQUIRES A TECHNOLOGICAL AS WELL AS POLITICAL SOLUTION

By ROBERT V. BARTZ '44

THAT the defense program is far from an unmixed blessing is tragically evident from the unemployment statistics released by the Bureau of Labor Statistics. E. R. Stettinius, when Priorities Director a few weeks ago, issued a proclamation forcing recalcitrant industrial concerns to assume defense contracts, which order was partially helpful in keeping labor, particularly that located in small plants, on the payrolls. However, OPM's failure to increase raw material production — and importation in the case of rubber and cork — early in the defense timetable has led to alarming shortages. The copper deficiency, for example, promises to be greater next year than our production three years ago, rendering countless electrical concerns stagnant and snipping off the incomes of thousands of skilled copper workers employed in the housing and automobile industries. Leon Henderson estimates that two and one-half million fabricated metal workers will be out of employment by December. The building industry's one and one-half million employees will probably be most seriously affected. Widespread priorities unemployment is injurious to this country, let alone the individual, because it drains the defense effort of its national spirit, and, therefore, this nation looks earnestly to government and technology for antidotes.

The problem is being met to some extent by the reorganized efforts of OPM'S Defense Contract Service. First of all, the Priorities Branch of OPM's Labor Division was successful with AFL backing in reversing the Army and Navy Munitions Board's stand on the negotiated contract. In World War I negotiated contracts resulted in considerable war-profiteering and industrial swindling, causing more than a little hesitancy of defense officials in doing that kind of business again. Therefore, this time competitive bidding was instituted — but with worse consequences. Three-quarters of all the defense contracts have been placed with only fifty-six corporations, with the result that labor surpluses or serious labor shortages have arisen in practically every part of the country; and portions of the nation, especially the South, where industry is not well located with regard to transportation facilities and heavy industrial centers, are, commercially, coming to a halt. Consequently, a compromise has now been effected such that competitive bidding serves as a guide for costs, but a negotiated contract may also be transacted on a bid within fifteen per cent of the competitive bid, if the United States Employment Service reports that labor may be displaced in that factory because of a priority order. This should turn out to be a worthwhile compromise. In addition to this measure, the heretofore little used system of sub-contracting is being spurred by the formation of sub-contracting pools including nearby small plants. Further political steps are needed, however. The lack of means for a redistribution of displaced labor is acute. One organization, the Buffalo Chevrolet plant, in coöperation with nearby defense plants, union executives, and the Employment Service, is retraining its workers for other jobs, but the difficulty of supporting the retrainees during their period of transition, which lasts months, arises. WPA, NYA and similar organizations uphold a fifteen-dollar-a-week ceiling, inadequate for families living comfortably one year ago. Whether the (*Continued on page 154*)

Serving the Railroads and *Saving* the Nation's Resources!

In these days of National Emergency, here are the important facts every railroad man should know about stainless steel railroad passenger cars:

• Every Budd car actually saves steel for Defense purposes, ***because it uses 40,000 pounds less than a conventional car.***

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• Built through and through of stainless steel and fabricated by the exclusive SHOTWELD★ system, these cars combine light weight with strength and safety.

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BUDD helps arm every branch of the service

Bodies for tough Army cars and trucks, bombs and shell cases, stainless steel parts for fighting planes and Navy ships today stream off Budd's production lines. Arming America's defenders is Budd's most urgent business today.

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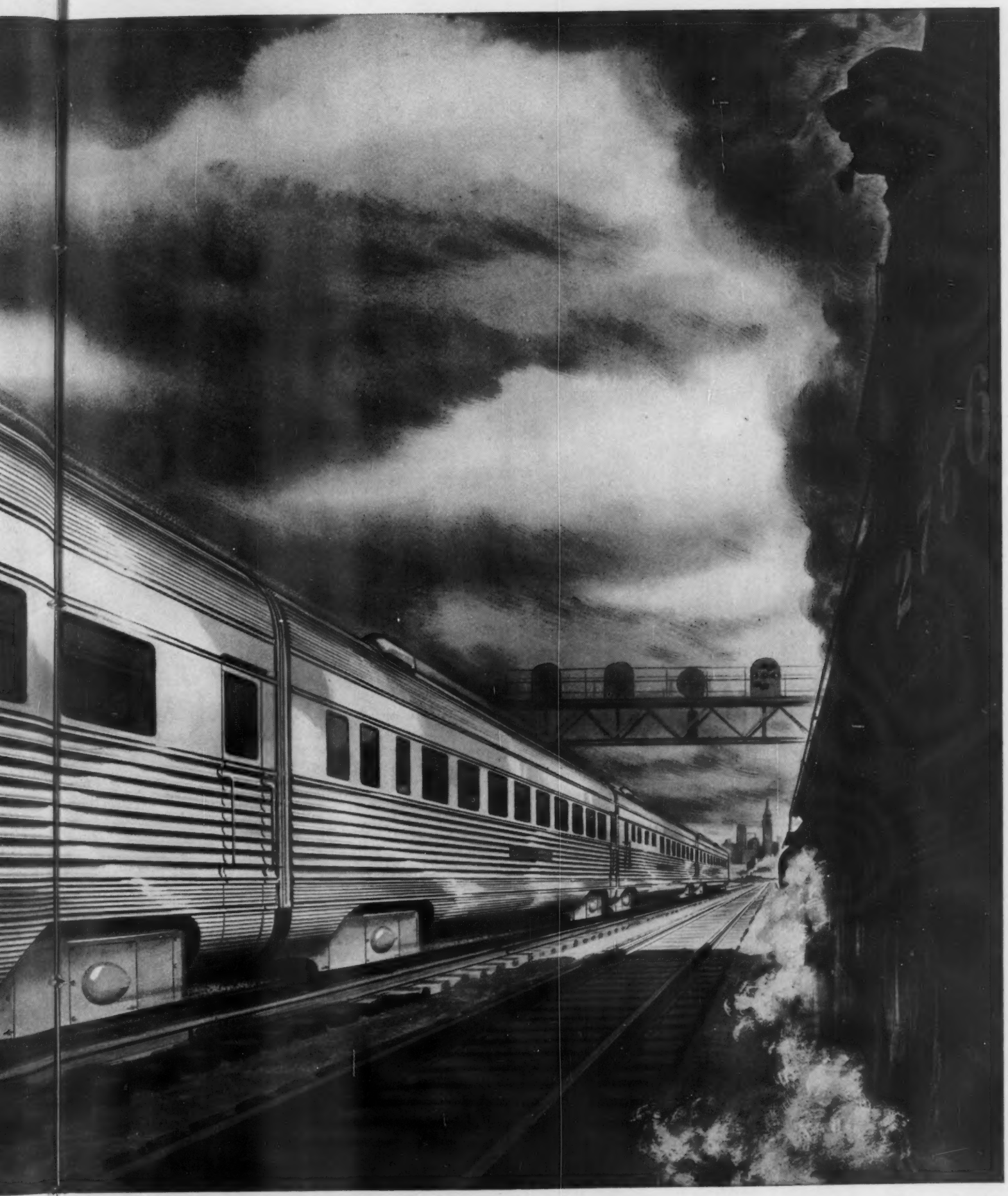
BUDD CARS



SAVE STEEL FOR DEFENSE

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FRANKLY SPEAKING . .

THE MINUTE MEN OF '41 ARE READY

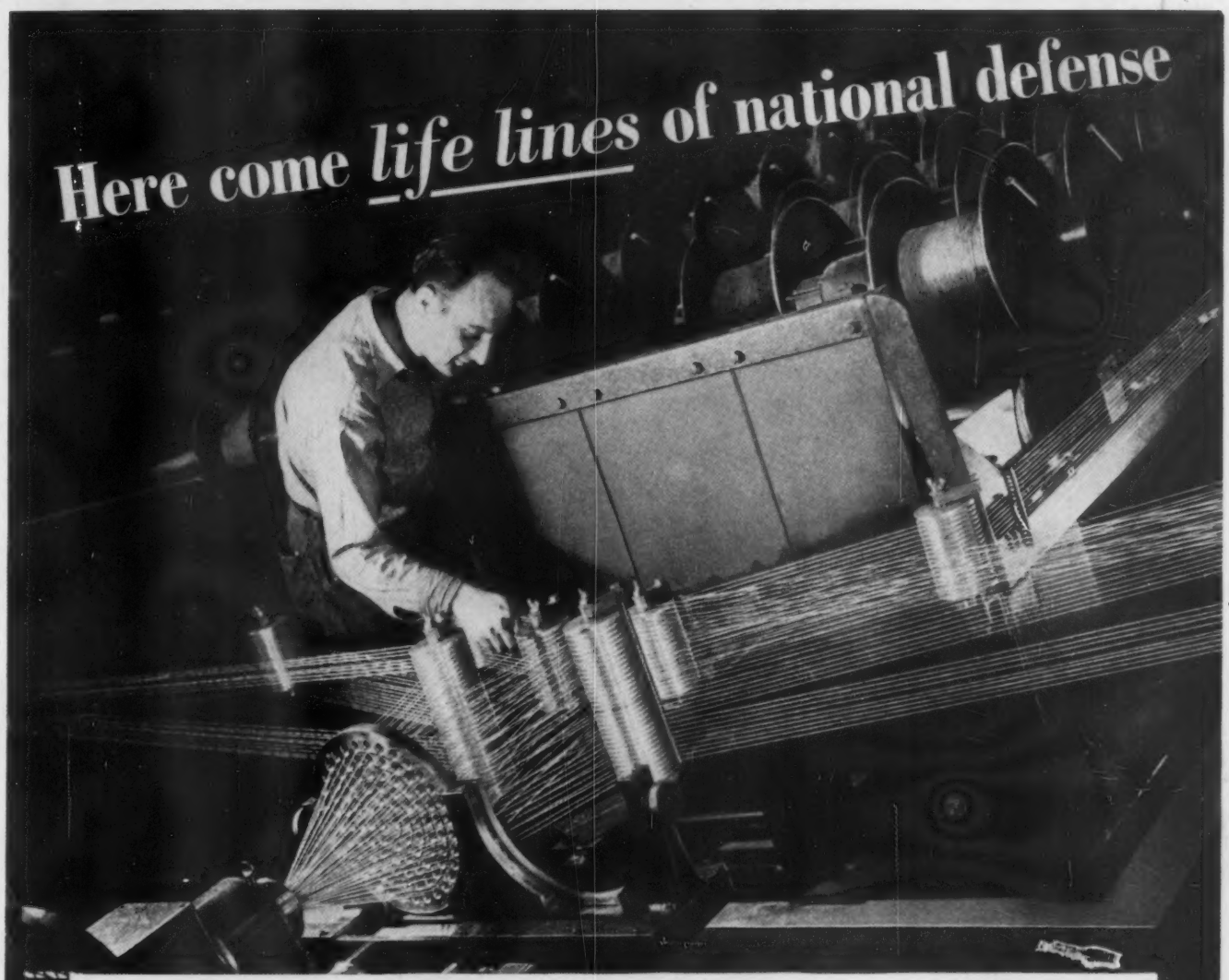
The Massachusetts Committee on Public Safety has again for the third time answered the call to duty. This group, appointed by Governor Saltonstall in the fall of 1939, has organized the civilian defense of Massachusetts. Far in the lead of any other state civilian defense in the nation, the Committee looks back on a long and impressive history. In days prior to the American Revolution, it was this body, then known as the Committees of Correspondence, that was the spark of the revolution, and that organized the minute men of '76.

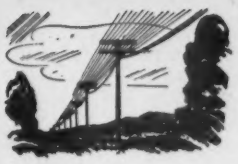
Under the chairmanship of the former Governor Channing H. Cox, plans have gone into effect with all possible speed for the protection of homes, industries, health, and vital public services in times of vital emergency. An estimated 100,000 trained citizens will be required on a voluntary basis, to act in time of war as air raid wardens, civilian "spotters," "watchers," firemen, policemen, Red Cross workers, and decontaminating parties of which 40,000 citizens are now trained. In each of the 351 cities and towns of Massachusetts, the Governor has appointed a chairman of a local Committee on Public Safety, on which rests the responsibility for executing civilian defense plans in his community. Under the executive director, Mr. J. W. Farley, are the five divisions of the committee headed by experts on a "dollar a year" basis: (1) Planning, (2) Production, (3) Public Relations, (4) Health and Social Services, (5) Services and Supplies. Expenses of the program are being carried by the state.

What, you may ask, are these extensive preparations for? We are not at war, yet. Do we expect Boston to be bombed, invaded by an army now freezing on the steppes of Russia? The answer is, there is a possibility, if slight, of just that. War is a matter of timing. England did not begin to prepare her civilian defenses until 1937. When tested in 1940, they were still far from perfected. The same outcries were heard. Were England to fall, the axis powers can out-build us in shipping at the rate of about seven or eight to one. With the English navy gone, and an airbase on Greenland, the whole New England industrial area would be subject to the same raids that England has suffered. While sufferings and loss cannot be entirely prevented, the panic and confusion, which ruined France, can be averted.

Already, text books have been printed and are in use: "Air Raid Warden's Manual," "Evacuation of Civilians," and related subjects. Under the activities of the Protection Division is the Women's Civilian Training School. The woman's place in total War has become of great importance; witness the accomplishments of the WRENS, the ATS, and the WVS in England. A School for Air Raid Wardens has been organized for Massachusetts. Without the services of the auxiliary Fire Department (*Continued on page 151*)

Here come *life lines* of national defense





Additional telephone lines speed defense everywhere.

Army camps must have plenty of telephone lines.

On ship and shore the Navy relies on telephone lines.

Industry requires, and obtains, more telephone lines.

Telephone lines are life lines. They carry the communications so vital to our expanding defense program.

The photograph shows wires being made into a telephone cable. Such cable—containing billions of feet of this wire—is being rushed by Western Electric to meet the urgent telephone needs of the armed forces and of industry.

So too, in vastly increased quantities, are being sped telephones and switchboards—and radio apparatus for the air forces and the Signal Corps.

The efficiency of Bell Telephone service is more than ever essential to government and business, and now as always Western Electric can be counted on to supply the life lines.

Western Electric *. . . is back of your Bell Telephone service*

Variation of storage tank temperature at M. I. T. solar house

HARNESSING THE SUN

(*Continued from page 136*)

efficiencies are thus impossible if only the heat from the sun's rays is employed, scientists have been examining other properties of this radiation in the hope of finding other more profitable methods of power conversion.

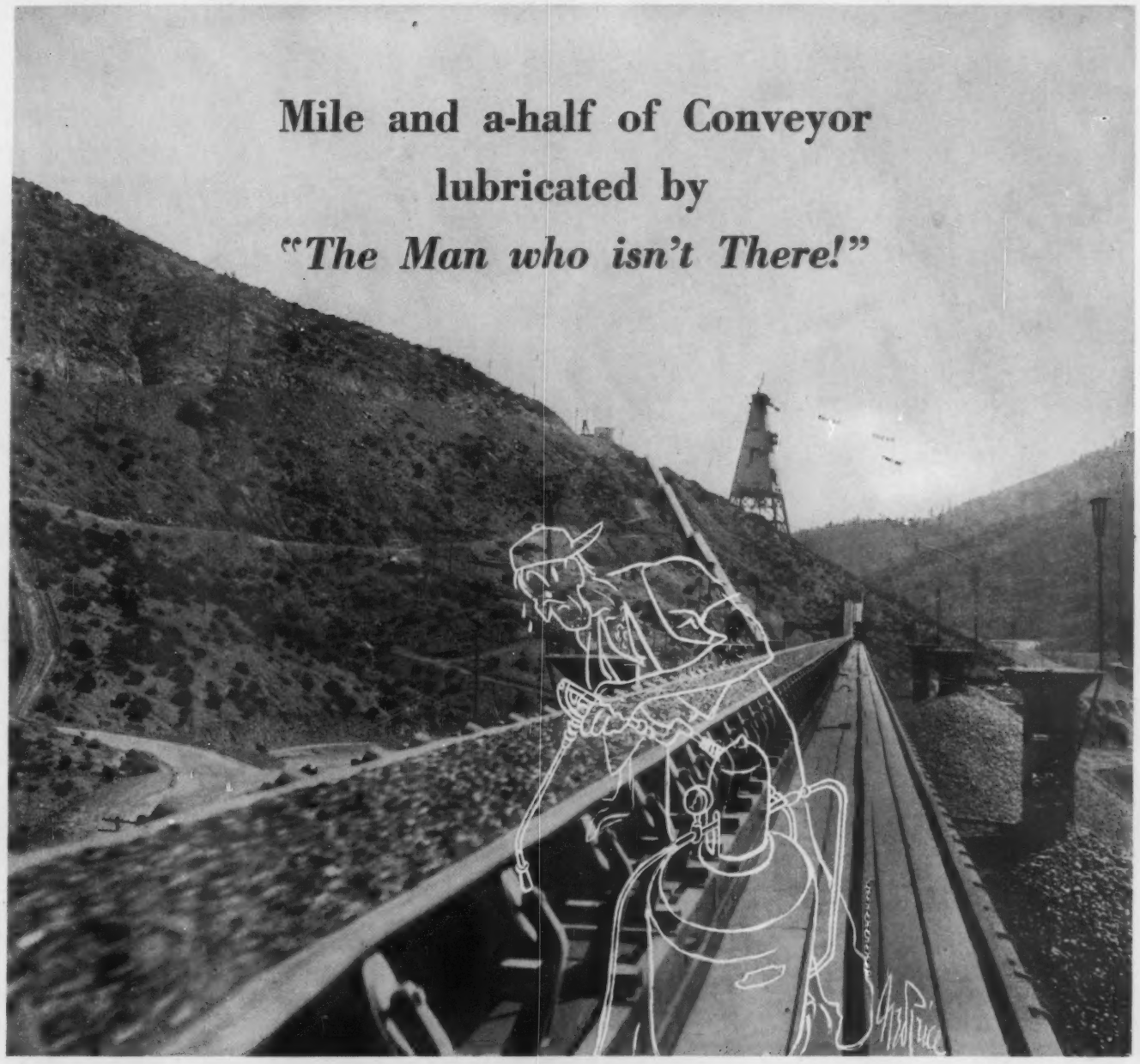
It has been found that the light quanta are able to knock electrons out of atoms or atomic lattices in crystals and produce an electric current, a phenomenon known as photoelectricity. This property of light is employed in camera exposure meters in which the current generated moves a galvanometer needle and thus measures intensity of illumination, and it is the project of the third branch of M. I. T. solar research to see if this same method is applicable to large scale current generation.

The light sensitive unit of such a device is known as a blocking layer photo cell, of which the copper oxide cell is typical. It consists of a massive plate of copper which has been oxidized on one side and then etched, thus producing a layer grading from cuprous oxide through all proportions of oxygen down to pure copper. The cuprous oxide surface is coated with a very thin layer of some other metal, so thin that it is transparent to light quanta. A light quantum, on hitting the cell, passes through the metal cover and the cuprous oxide into the layer of composition varying between copper and cuprous oxide, the so-called blocking layer. Here it succeeds in breaking an electron away from the crystal lattice, and this electron finds it easier to migrate toward the copper than through the copper oxide to the metal film. This unidirectional motion of the electrons constitutes an electric current.

How important is this phenomenon in generating power from sunlight? Quantitative experiments have shown that of the visible light quanta falling on a cell only five per cent succeed in freeing an electron, and that the voltage efficiency is about ten per cent. The overall efficiency is, therefore, only .5 per cent, but, as in the thermocouple, it is possible that this efficiency may be increased as much as tenfold. Such an accomplishment will not be easy, however, for physicists actually know very little about what goes on in the blocking layer of a photo cell. In order to supply this data, a research project is being initiated in the Electrical Engineering Department in connection with a broad program of study of insulators and semi-conductors, from the viewpoint of atomic physics.

The last of the M. I. T. solar energy projects, like the one just discussed, depends upon the special properties of sunlight rather than on its overall energy content. Everyone is familiar with the basic action in plant leaves whereby carbon dioxide and water are converted into carbohydrates and oxygen by means of sunlight in the presence of the catalyst chlorophyll. If man were able to copy nature and utilize light to produce substances of high energy content, a vast supply of power would become (*Continued on page 152*)

Mile and a-half of Conveyor lubricated by *"The Man who isn't There!"*



● Yes, 16,000 bearings at the Shasta Dam project, greased regularly by Yehoodi's old man—the phantom of the operation.

Seriously, the secret is New Departure anti-friction bearings, self-sealed against dirt and lubricated-for-life!

Just another "new departure" by New Departure—another "famous first" by an alert company whose products are *ideas* as well as ball bearings.

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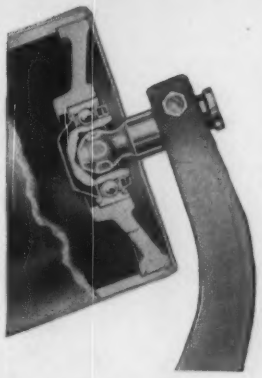

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THE FORGED STEEL BEARING

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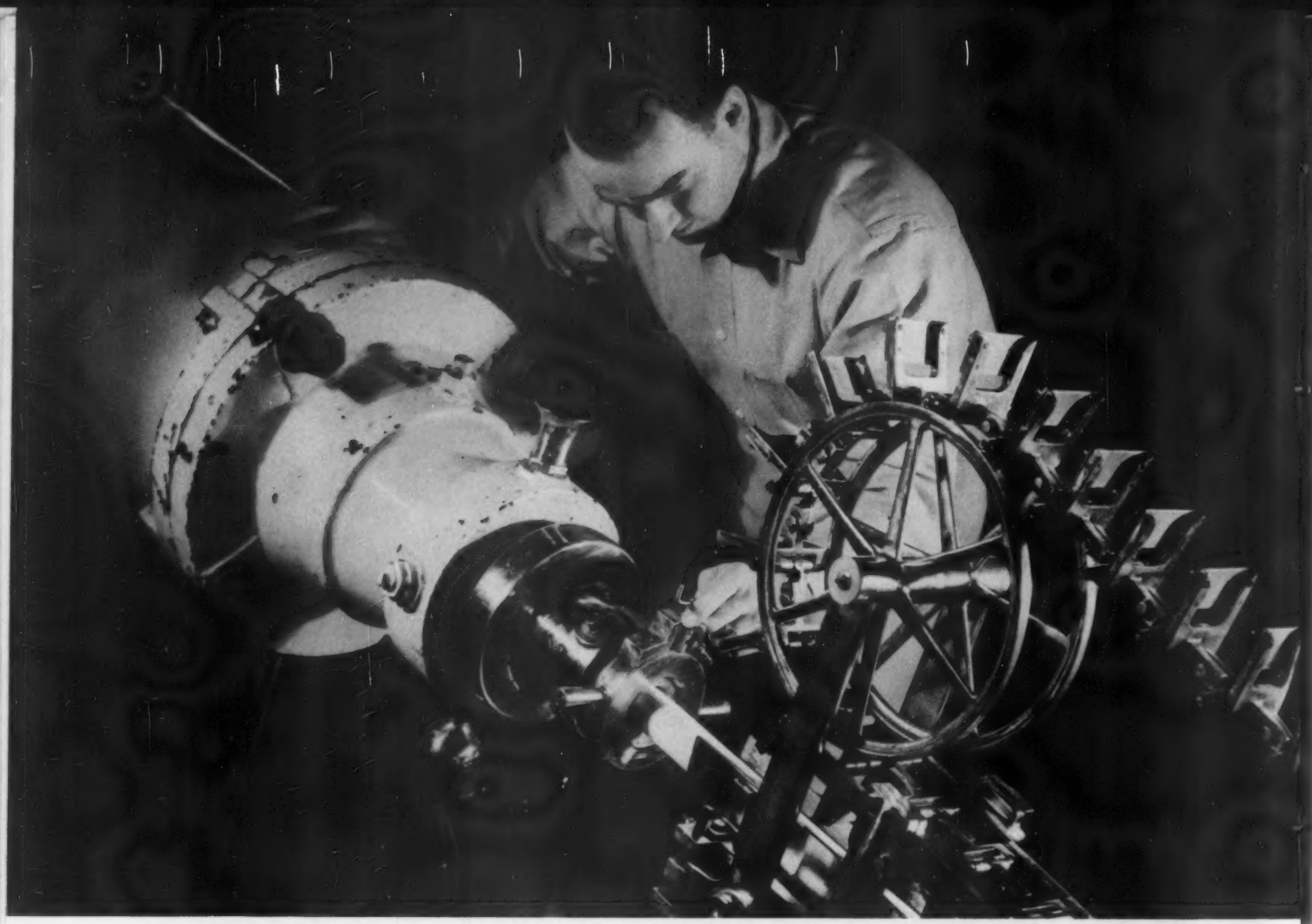


Some soaps are milled into a solid "stick" before being cut, and stamped into shape — *Procter & Gamble*

$99^{44}/_{100}\%$ PURE

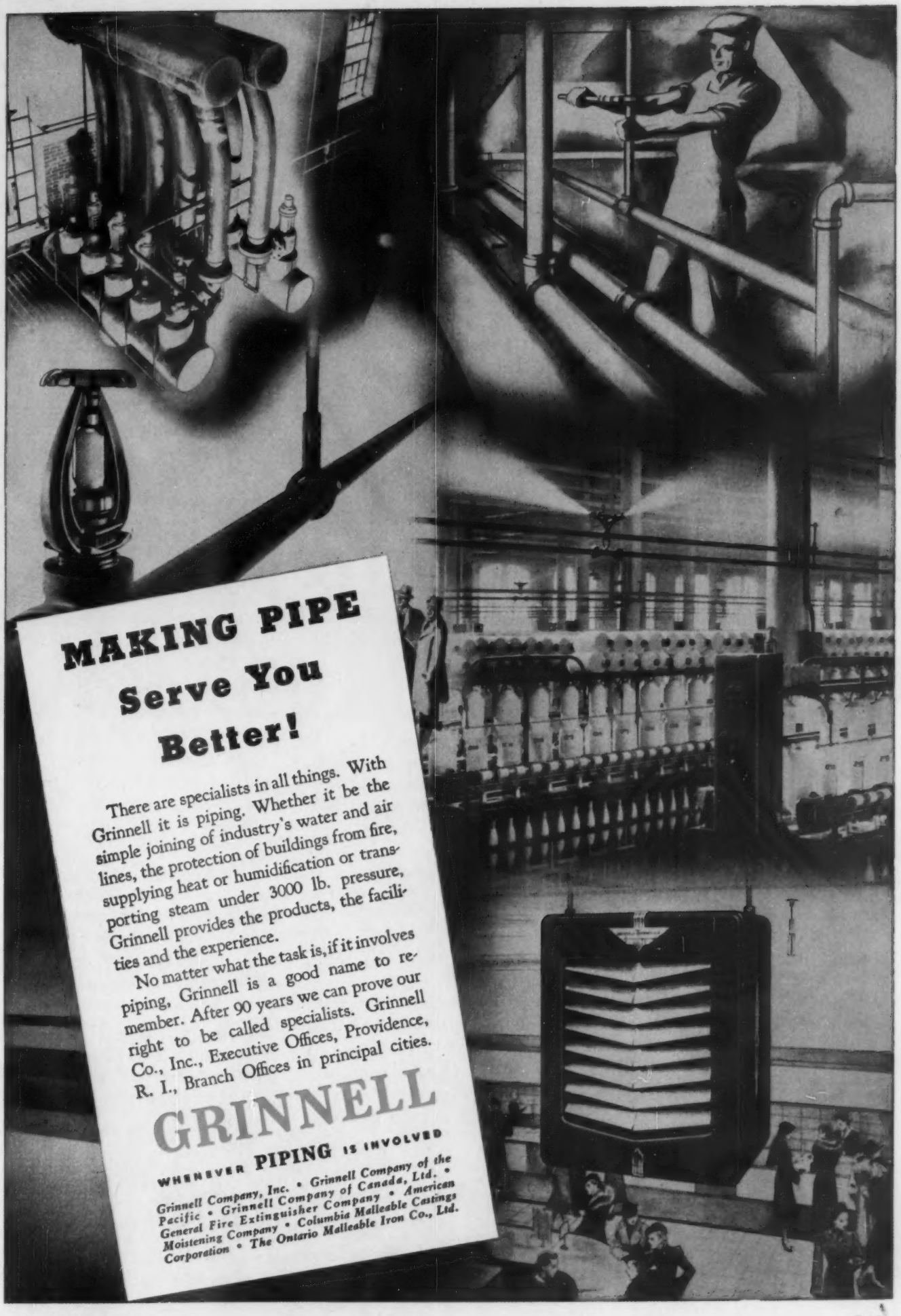
(*Continued from page 140*)

One of the earlier attempts at detergent synthesis was the manufacture of the so-called "sulfated oil." Instead of being treated with a base, oils were treated with sulfuric acid. The resulting compounds contained the fatty medium in the positive radical, and consequently were not subject to precipitation by hard water. They were too low in cleansing value, however, to affect soap production.

The partial success of this first attempt was an inspiration for more intensive research, and recent accomplishments have been much more useful. Of particular interest is the class known as *alkyl sulfates*. These are produced by three major reactions: The fatty acid or oil is reduced by high-pressure catalytic hydrogenation to the corresponding alcohol. The alcohol is treated with sulfuric acid to yield an alkyl sulfuric acid: $C_{12}H_{25}OH + H_2SO_4 = (C_{12}H_{25})HSO_4 + H_2O$. The alkyl sulfuric acid is then neutralized with a base to form a sodium or other metallic alkyl sulfate. The astounding property of these detergents is their resistance to precipitation in hard water. Strangely enough, many of the heavy metal alkyl sulfates are more soluble than the sodium salt, which in turn is more soluble than the potassium salt. Also, different properties can be obtained by the use of different original hydrocarbons. By varying the hydrocarbon content and structure, characteristics of practically every soap can be duplicated.

Another interesting group of detergents is that known as the "acylated sulfonates." These are mainly organic substitution products different chemically from soaps by the addition of various organic and inorganic radicals to the ordinary soap molecule. For example, the compound $C_{17}H_{33}-C-O-CH_2-CH_2-SO_3Na$ has the formidable name "oleic acid ester of sodium isethionate," but differs from ordinary sodium oleate by the addition of the fourth, fifth, and sixth terms. These compounds have the same properties as the alkyl sulfates, but because of their complex structure are subject to many variations. Research is still being done on the preparation and properties of these acylated sulfonates in an attempt to find a satisfactory compound for every possible use.

Today the soap industry is no longer simply a manufacturing venture. It is an active participant in chemical research. It is looking for new possibilities, and new ways to utilize its by-products. Soap is an essential of everyday existence. Even if it were not constantly being improved upon, we would still have to accept it and put it to its customary uses. But every day reveals more new advances in the field. Following the true engineering spirit, the soap industry too is demonstrating that better things can — and will — be done.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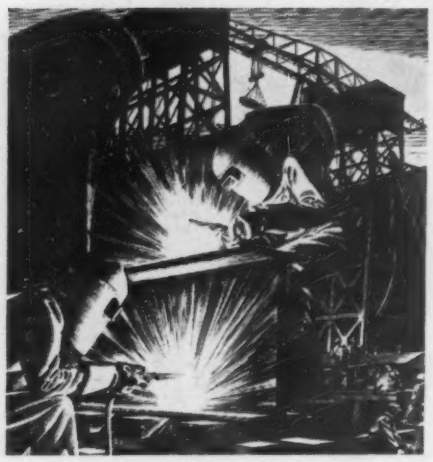
The ramparts we build...



AS OUR COUNTRY moves through perilous world events, national defense is uppermost in our minds. Is defense production fast enough? Is American industry turning out the goods? How are American engineers and production men meeting defense problems?

Here's how matters stand at Westinghouse:

We are engaged in building more than $300,000,000 worth of equipment for the national defense program. On our books are more than 3,600 defense orders. To meet schedules, we must produce $960,000 worth of apparatus every day—$40,000 every hour—between now and the end of 1941.

Every one of the Company's 26 manufacturing divisions is working on national defense projects; most of them on a three-shift basis.

Employment is at an all-time peak of 75,000, a gain of more than 25,000 since a year ago. One in three Westinghouse employees is new.

To avoid delays due to shortages in materials and to release metals needed for other defense projects, substitute materials committees have been organized in every Westinghouse plant to find ways to make use of new materials wherever possible. One result: our Merchandising Division alone has found ways to save 1,500,000 pounds of aluminum out of next year's manufacturing schedule. That's enough to build 130 Army bombers.

Many things we are making for the Navy, Army, and defense industries are military secrets, but we can mention:

Parts for control units on anti-aircraft guns.

Special land, sea, and air radio equipment for the Army and Navy.

High-speed X-ray equipment, capable of examining soldiers at the rate of one a minute.

Army binoculars.

Fluorescent lamps for "blackout" plants and others.

Secondary networks for defense plants. These are systems of power circuits and equipment so arranged that if one part of the factory is destroyed, current will continue to be available in all undamaged sections.

Some of the things we're making for air defense are:

Special meters and instruments for Army airplanes.

Lightweight generators and voltage regulators to supply and control electric power in Army planes.

Bomb fuses, now being turned out at a high rate. Production will be doubled again in a few weeks.

Plastic parts for aircraft, including Micarta pulleys and fair leads to guide the control wires inside planes.

Radio sending and receiving apparatus.

Lighting systems for airports and seadrome lights capable of converting open waterways into landing bases for seaplanes.

Now at work on propulsion equipment for more than 100 Navy ships is the Westinghouse Steam Division plant at South Philadelphia.

Driving gear for 80 merchant vessels also is being made at this plant.

Besides helping to build our first lines of defense Westinghouse is supplying power equipment urgently needed for the speed-up of its own and other defense industries.

Our East Pittsburgh Works this year will *double* its 1940 production of generating equipment.

The Generator Division completed this year the three largest water-wheel generators in the world—108,000 kilovolt-ampere giants for Grand Coulee.

The Motor Division will produce enough motors in 1941 to develop 2,660,000 horsepower; enough power to drive all the machinery in 50 steel mills. Majority of these motors will be driving machinery for defense.

This, in outline, is the way the Westinghouse Company and Westinghouse engineers are doing their share in national defense.

Westinghouse

Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.

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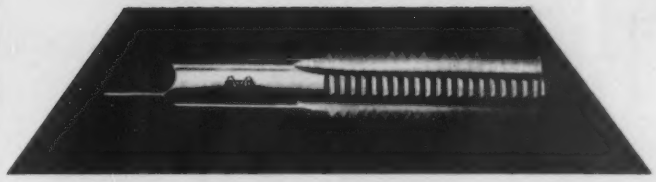
FRANKLY SPEAKING . .

(*Continued from page 144*)

of 30,000 men, London would be in ruins today.

Because of the publicity on bombings and air raids, the average person will probably hear more about the Protective Division than any other — the A.R.P. (air raid precaution). The Army Air Corps has under construction thirteen information centers, each in a major city on the Atlantic Coast. Minute by minute reports from more than 6,000 field observers will enable the Air Corps experts to plot the paths of enemy bombers and direct the swift counterattack of interceptor planes. In a matter of seconds, the complicated machinery of aerial defense will be in motion. While this is going on, the civilian air raid warden will flash out warnings to the districts in line of attack. Where perhaps three or more fires can be handled at once in normal times, fifty or more simultaneous fires caused by thermite incendiary bombs can be handled with the help of the civilian auxiliary fire fighters. First aid parties must be immediately available; decontamination parties will be specially trained and equipped to neutralize and enclose areas affected by persistent gases. Air raid wardens in every block must sound the signals of air attack, report bomb damages, and take immediate action in the event of damage to water mains, sewers, and other public utilities.

These then are the conditions under which the Committee of Public Safety will operate if necessary. It is doing its job thoroughly, a tremendous job worthy of the sacrifice of all the citizens of Massachusetts pulling together.



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To make *a good tap* for a particular job may require a special kind of steel, expensive automatic machines, milling machines, accurate grinders that will finish threads to dimensions much less than a human hair, and years of experience in heat treatment.

These are some of the reasons why it pays to look for the "G.T.D. Greenfield" trade mark on taps and other threading tools — the mark of the oldest and largest company in the business.

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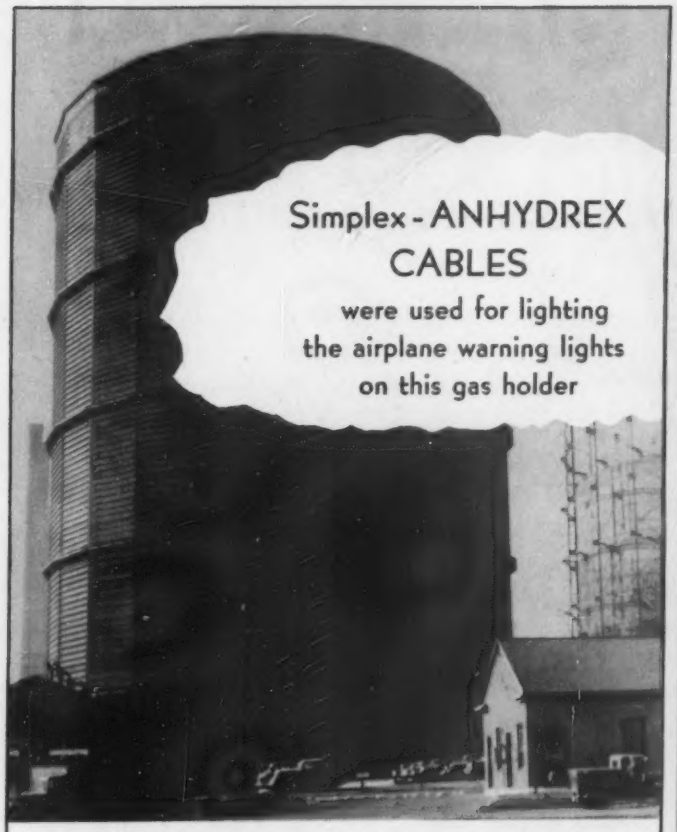

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HARNESSING THE SUN

(*Continued from page 146*)

available. This does not mean that research should necessarily be directed toward reproducing photosynthesis in the test tube, but rather it should search for the necessary catalysts and conditions which would allow one to carry out some simple energy-storing reaction like the decomposition of water. A major problem would be to devise a reaction with suitable intermediate steps in order that the small energy quanta of which light is composed could be employed one step at a time, just as nature undoubtedly does in the leaf of green plants.

Research at M. I. T., however, is approaching this problem somewhat differently. Rather than attempt to produce a stable product of great energy content such as fuel or explosive, one may attempt to capture the energy of the intermediate products and convert it into electricity. It is necessary to find a photochemical reaction in which the passage from an unstable to stable state can be made to proceed as the electrode reaction in a cell. Such an oxidation-reduction reaction which is now being carefully studied consists of an organic dye, thionine, and ferrous iron in the form of a ferrous sulphate solution. The reaction can be represented in the following reversible equation.

$$\text{dye} + Fe^{++} = \text{leukodye (colorless)} + Fe^{+++}$$

Ferric iron is a much stronger oxidizing agent than thionine; therefore, in the dark, all the thionine is in the form of the dye, and the iron in the reduced state. If the mixture is exposed to light in the range absorbed by thionine, visible light from 5,000 to 7,000 Angstroms, the thionine molecules become capable of oxidizing ferrous iron. As the leuko compound is colorless, the reaction can be followedby watching the decolorization of the solution. This is the most light sensitive reaction which has yet been discovered. As the composition of the solution changes by illumination, its electrode potential also changes. If two platinum electrodes are placed in the solution and one is illuminated and the other kept dark, a potential difference is established and a current flows from the dark to the illuminated electrode.

There are two qualities of such a cell which must be determined if its industrial importance is to be ascertained: first the electromotive force produced by a given light intensity, and second the current which may be drawn from the cell. The variations in potential with intensity of light, with different concentrations of thionine and iron, and with solutions of different *pH* have been studied and optimum values determined. In order to produce power efficiently, the cell must be able to give a strong, steady current, but whether or not such efficiency can be hoped for it is too early to say.

Thus research on converting the sun's rays to useful power has only begun. Latest advances indicate that the likely fuel supply of the future is sun.

MOUNTING POWER FOR ALLIED WAR BIRDS

THIS engine mount destined for overseas service on an American made fighter plane is being fabricated by the best known method of joining metal — that is, by welding. For welding makes equipment a homogeneous, permanent unit, light yet exceptionally strong. This versatile process utilizes the Airco oxy-acetylene flame to make design problems vanish. It is applied rapidly and economically even under difficult shop and field conditions. The apparatus employed is simple, portable, easy to operate. » » So versatile is the oxy-acetylene flame, so varied are its useful applications in the metal working field, that it has long since been drafted into service to speed defense by swiftly cutting metal to close tolerances, by hardening metal surfaces for longer wear, by cleaning them for faster, longer-lasting paint jobs, and by gouging metal with amazing speed and accuracy.

The interesting booklet "Airco in the News" shows pictorially many ways in which Airco products and processes are being used to help industry speed up production. Write for a copy.

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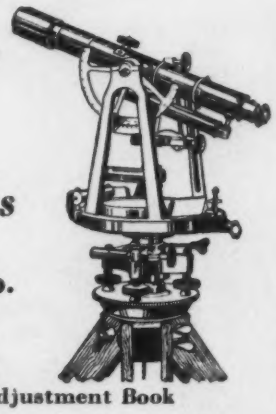

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PRIORITIES UNEMPLOYMENT

(*Continued from page 141*)

government can appropriate additional funds for its already diminished eleemosynary budget to care for these workers and their families is yet another question to be answered with action.

But what have the engineer and scientist contributed to a long-term solution and how can they stop the ever increasing flow of men from established American industries? The answer must lie in industrial diversification, technological advance, the conversion of plants and their labor to defense needs, and the development of new by-products. Illustrative of this is the newly created industry of salvaging tin plate from tin cans. Tin has been on the "critical" priorities list for some time, but the thought of salvaging the one and one-half per cent tin plating from America's tin plate was suppressed by the Technological Committee of the National Academy of Science's statement to the government that the project was not economically feasible and, accordingly, should be carried out only in the case of an extreme shortage of the raw product. However, an adventurous concern near the nation's capitol promptly employed new methods and was shortly thereafter earning three and one-half dollars per long ton of castoff cans, a small but almost invariable profit. The difficulties in the process are obvious, but with persistent effort this challenge to United States engineers was well met, and men were blotted from unemployment rolls by a new industry. Union Carbide and Carbon Company is manufacturing a wholly satisfactory substitute for coating steel cans, vinyl resin lacquer. For storing paint terne plate (lead and tin) is replacing the traditional tin coating for steel cans. Goodyear Tire and Rubber Company is manufacturing "Pliofilm" to cover certain foodstuffs formerly stored in tin cans and is thus doing its share to replace employment lost through priority control. Other evidence of what has been done includes the replacement of aluminum in brake cylinders and pistons with powdered and cast iron respectively and the replacement of zinc — in demand for the manufacture of brass cartridges — in dies with plastics, such as in carburetor bowls. By these actions United States technology is thrice serving its country: it is encouraging the use of priority raw materials in front line defense by demonstrating that in nearly all cases suitable substitutes can be developed for non-defense purposes; it is effectively converting the factories themselves and their labor to the manufacture of defense products; it is evolving fresh industries to absorb labor displaced from concerns eliminated by priority control and is, therefore, uplifting the vital morale of our nation.

Cheek-by-jowl with newly born industries sit old industries, almost mortally afflicted with the crisis. With the rise of priorities unemployment, the defense effort has thrown down the gauntlet to American technologists. It is evident they will snatch it up with wonted energy and vision.

"No smell, noise, jolt, etc..."

"Positively the most perfect machine on the market" was the manufacturer's description of this horseless carriage in 1900. And only the rich could afford such perfection. Parts were finished by hand. Interchangeability of parts was unheard of. Then came man-made abrasives such as "Carborundum", and later "Aloxite", to help bring about the mass production that has made available to everybody that miracle of transportation—the modern American car.

The use of man-made abrasives made it possible to finish parts to uniformly close limits of accuracy. Interchangeable crankshafts, cams, cylinders, pistons, gears could be produced in quantity for instant assembly. Better-built cars became available at new low prices. And the same mass production methods extended to other products have helped bring us a new standard of living.

A leader in the advancement of grinding, Carborundum now supplies abrasive products for obtaining finishes of unbelievable accuracy. No matter what type of industry you may be identified with after graduation, you will find it profitable to use Carborundum engineering experience. The Carborundum Company, Niagara Falls, N. Y.

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ABRASIVE PRODUCTS
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WIND POWER

(*Continued from page 133*)

will make it possible to estimate with more certainty than now exists the amount of power which can be developed by a wind turbine unit under a given wind regime.

3. Furnish data which may lead to simplification and the use of less material in future designs.

Until the tests which are proposed have been carried out, there will have been no real substantiation of the estimates which led to the S. Morgan Smith Co., sponsors of the project, to undertake this large-scale experiment. Engineers, as a group, prefer to speak of their projects only after they have been proven successful. Because this project has as yet not had an opportunity to prove its degree of success, there is naturally considerable hesitancy in describing it in too much detail at this time.

Grandpa's Knob was chosen as a site for the test after extensive investigations based on weather map studies, anemometer recordings in the field, balloon tests, wind tunnel tests on models of mountains, and the correlation of the effect of meteorological conditions upon tree growth. Other sites would have given higher power outputs, but Grandpa's Knob combined the virtues of fair power output, icing conditions that were not too severe, and accessibility.

The principal structures which have been built at the site are as follows:

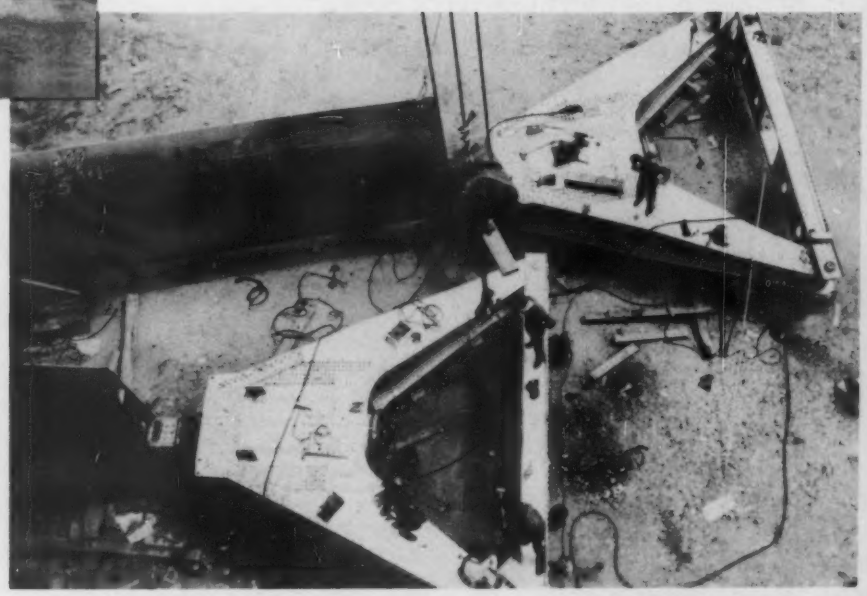
1. The wind turbine itself, consisting of the stainless steel blades and the power house, mounted on top of a 110 foot tower, and rotating about a vertical axis on the tower top to follow wind direction changes.

2. The control house, in which are located the electrical switchgear for the unit, and numerous instruments recording the action of the turbine. The unit is designed so that it can operate as a fully automatic station, but it can also be controlled manually, either from the control house or from the power house aloft. The readings from the instruments recording the operation of the turbine will be recorded photographically with motion picture cameras.

3. An anemometer mast, 185 feet high, with cross arms 65 feet long, extending north, south, east and west, at an elevation of 120 feet above ground. This mast will carry 17 anemometers of various types, which will serve as the basis for an extended study of gust formations on mountain tops.

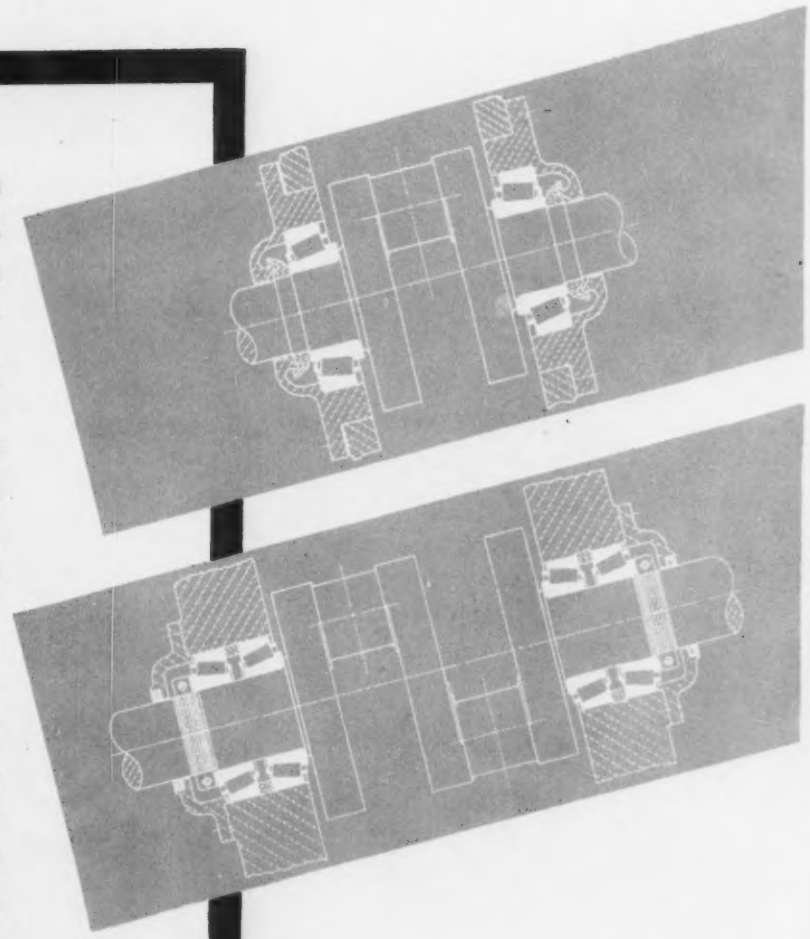
At this writing the unit has been brought to full speed by the wind under governor control, but under no load conditions. It is expected that an attempt will be made to develop electrical energy at an early date.

Hauling the blade up the mountain



Assembling the blades preparatory to mounting on tower

WHAT BEARINGS WOULD YOU SPECIFY FOR THE CRANK SHAFT OF AN OIL FIELD ENGINE?



If you were called upon to design a gas, Diesel or steam engine for oil field work how would you support the crank shaft? If you knew your bearings you wouldn't have to think twice. You would do as most of the leading engine builders do; you would mount the crank shaft on TIMKEN Tapered Roller Bearings—single or double, according to the length of the shaft and the H.P. of the engine.

This would assure a smoothly-operating engine that would transmit its maximum power rating to the job, for main bearing friction would be eliminated. Full protection against both radial and thrust loads would be assured. Wear on the ends of the crank shaft would be prevented because all movement takes place within the TIMKEN Bearing itself. Main bearings would seldom, if ever, have to be replaced on account of wear. Crank shaft alignment would be maintained indefinitely.

You can learn a lot more about crank shaft bearings and many other applications by studying the Timken Reference Manual. We will gladly send you a copy. Write for it. Know your bearings—be a better engineer.

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G-E Campus News

MOSQUITOES DON'T LIKE RED LIGHTS

OUT in Cleveland, Ohio, a group of engineers and entomologists has been spending a lot of warm summer evenings sitting around under a string of colored lights. But any passerby who got the impression that they had joined the rocking-chair brigade would be very much mistaken. They were conducting a scientific experiment to determine what color lights attract, and what repel, night-flying insects.

Results: mosquitoes and most other night-flying insects don't like red lights, prefer blue. But since red is not a very satisfactory color to work under, the scientists suggest that if you must work under a lamp outdoors, yellow light provides the maximum advantages to human beings with the minimum attraction to insects.

LEFT-HANDED BUCKETS

UNLIKE the famous fellow who wanted a left-hand monkey wrench, the young man at the window is perfectly in the right if the buckets he wants are the buckets for a steam turbine. For a double-flow turbine for ship propulsion has both right- and left-hand buckets.

There's an important reason for using this construction. Though it sounds more complicated, a double-flow turbine operates at higher speed, weighs less, and occupies less space than a single-flow one. All these are distinct advantages when the equipment has to be installed in a ship, where space is at a premium. And in times like these, when turbines must be turned out in a hurry, the smaller metal parts required represent an advantage in manufacture, too.

General Electric, which has probably built as many naval and marine turbines as any other single manufacturer, is right now making more of them than at any time in its history. And by taking advantage of every engineering and manufacturing advance, it is turning them out on what approaches a mass-production basis.

WANT A BOOKLET?

NOT required reading in any course we ever heard of. But if lightning should strike you some day, you'd be glad to know what hit you. This booklet explains the whys and wherefores of lightning. Tells you how to recognize lightning when you see it, how to catch it if you should want to take some home to play with, etc. In fact about the only thing missing is a "lightning" index to enable you to thumb to your favorite passage in less time than it takes to say "blitz."

And if you have just been on a textbook-buying binge, you may be interested in the fact that this 24-page pamphlet is free.

If you *are* interested, write to the General Electric Company, Dept. 124E, Schenectady, N. Y., and ask for "The Story of Lightning," based on the work of Dr. Karl B. McEachron author of the book, "Playing with Lightning."

GENERAL ELECTRIC

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